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**Inoue**

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# (54) IMAGE FORMATION APPARATUS


(71) Applicant: **Oki Data Corporation**, Tokyo (JP)

(72) Inventor: **Hiroyuki Inoue**, Tokyo (JP)

(73) Assignee: **Oki Data Corporation**, Tokyo (JP)



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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
***G03G 15/00*** (2006.01)

(52) **U.S. Cl.**
CPC ............ ***G03G 15/50*** (2013.01); ***G03G 15/5008*** (2013.01); ***G03G 15/6564*** (2013.01); *G03G 2215/00721* (2013.01)

(58) **Field of Classification Search**
USPC .......................................................... 399/66
See application file for complete search history.


(56) **References Cited**

FOREIGN PATENT DOCUMENTS


JP H04-050961 * 2/1992 ............ G03G 15/00

* cited by examiner



*Primary Examiner* — Clayton E LaBalle
*Assistant Examiner* — Jas Sanghera
(74) *Attorney, Agent, or Firm* — Marvin A. Motsenbocker; Mots Law, PLLC


## (57) ABSTRACT


An image formation apparatus includes an image carrier on which a developer image is to be formed, an image transfer device configured to transfer the developer image formed on the image carrier to a medium at an image transfer position, a controller configured to control drive of the image carrier and the image transfer device, a first medium feeder configured to feed the medium to the image transfer position along a medium conveyance path extending from the first medium feeder to the image transfer position, and a medium detector provided between the first medium feeder and the image transfer position in the medium conveyance path. The controller is configured to control the drive of the image carrier on the basis of a medium-detection result by the medium detector.


**24 Claims, 14 Drawing Sheets**

CONFIGURATION OF IMAGE FORMATION APPARATUS IN FIRST EMBODIMENT

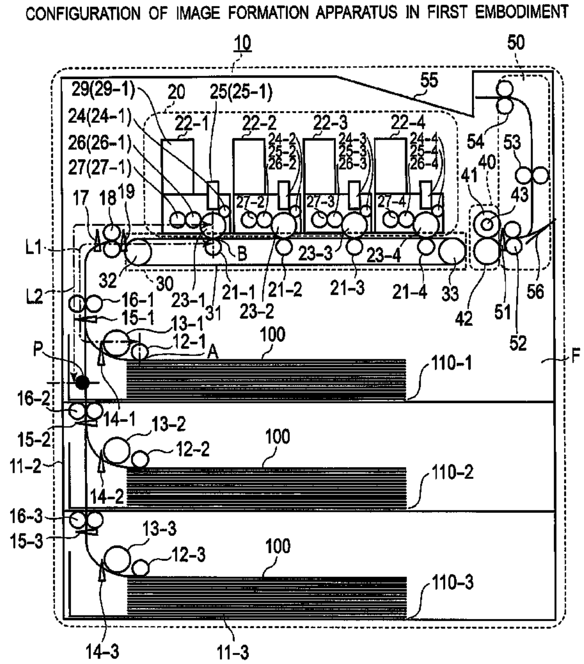


FIG. 1

CONFIGURATION OF IMAGE FORMATION APPARATUS IN FIRST EMBODIMENT

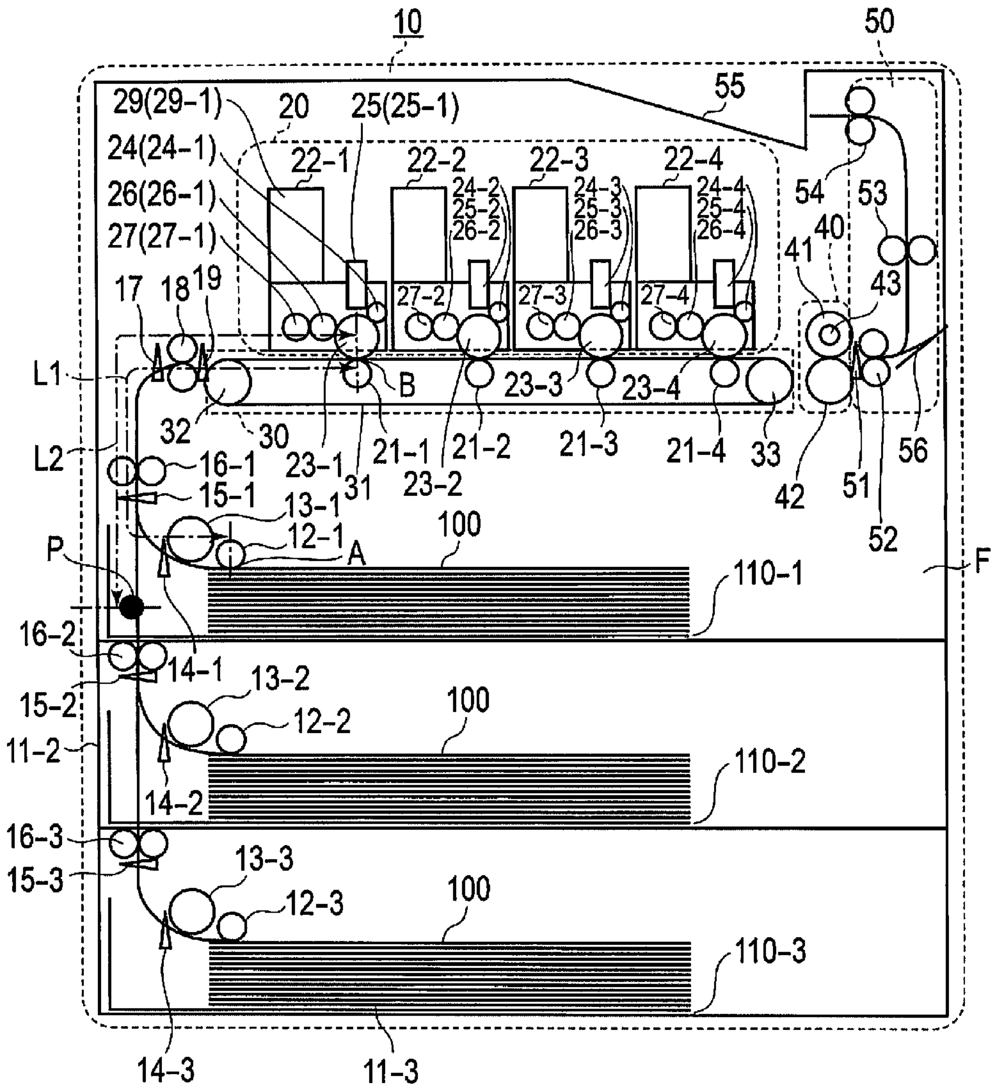


FIG. 2

CONFIGURATION OF IMAGE FORMATION UNIT OF IMAGE FORMATION APPARATUS SHOWN IN FIG. 1

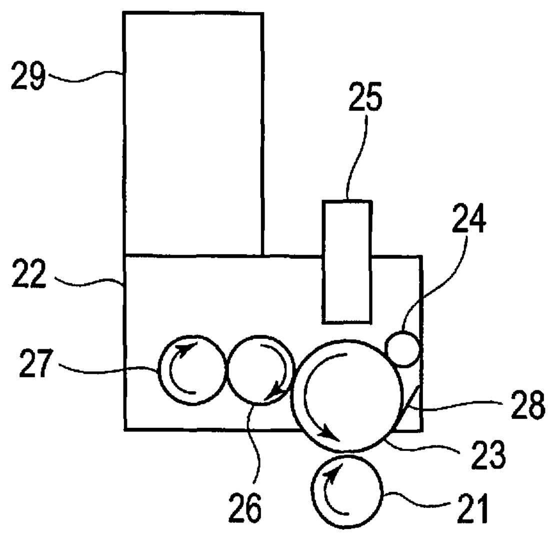


FIG. 3

CIRCUIT CONFIGURATION OF MAIN BODY OF IMAGE FORMATION APPARATUS SHOWN IN FIG. 1

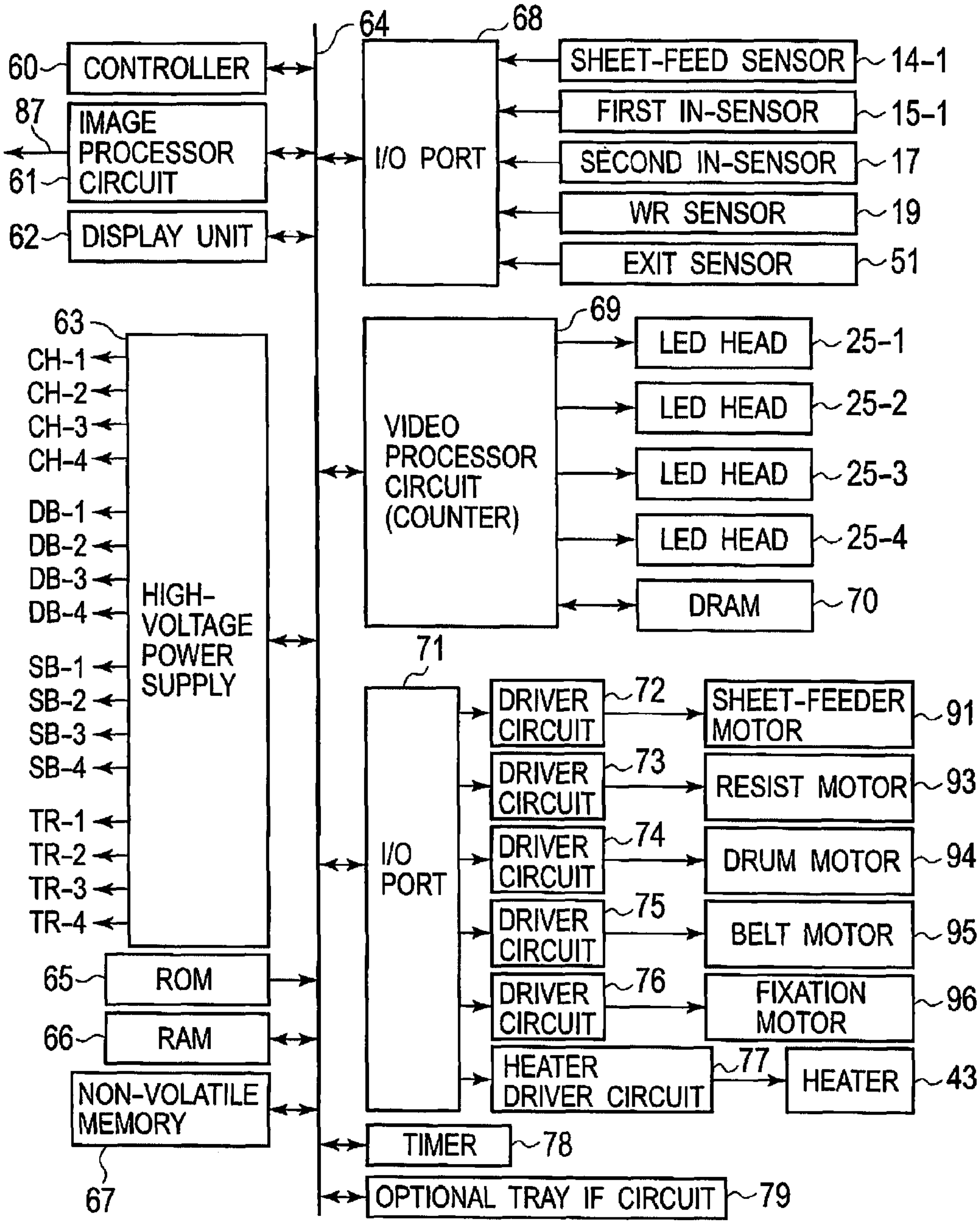


FIG. 4

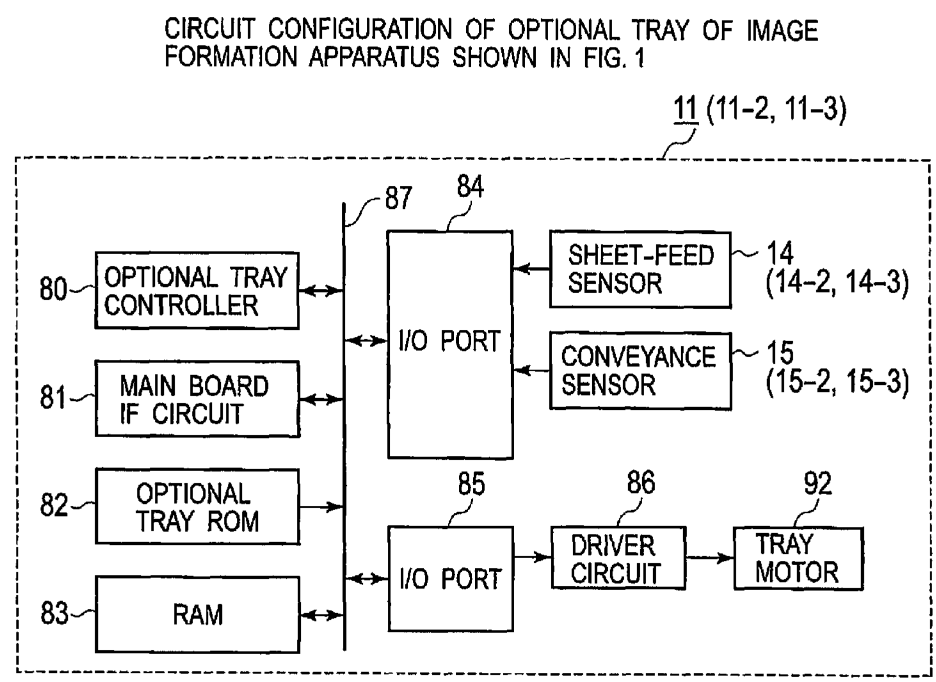

CIRCUIT CONFIGURATION OF OPTIONAL TRAY OF IMAGE FORMATION APPARATUS SHOWN IN FIG. 1
11 (11-2, 11-3)
87
84
80
OPTIONAL TRAY CONTROLLER
81
MAIN BOARD IF CIRCUIT
82
OPTIONAL TRAY ROM
83
RAM
I/O PORT
SHEET-FEED SENSOR
14 (14-2, 14-3)
CONVEYANCE SENSOR
15 (15-2, 15-3)
85
86
92
I/O PORT
DRIVER CIRCUIT
TRAY MOTOR

FIG. 5 FLOWCHART OF IMAGE FORMATION APPARATUS IN FIRST EMBODIMENT

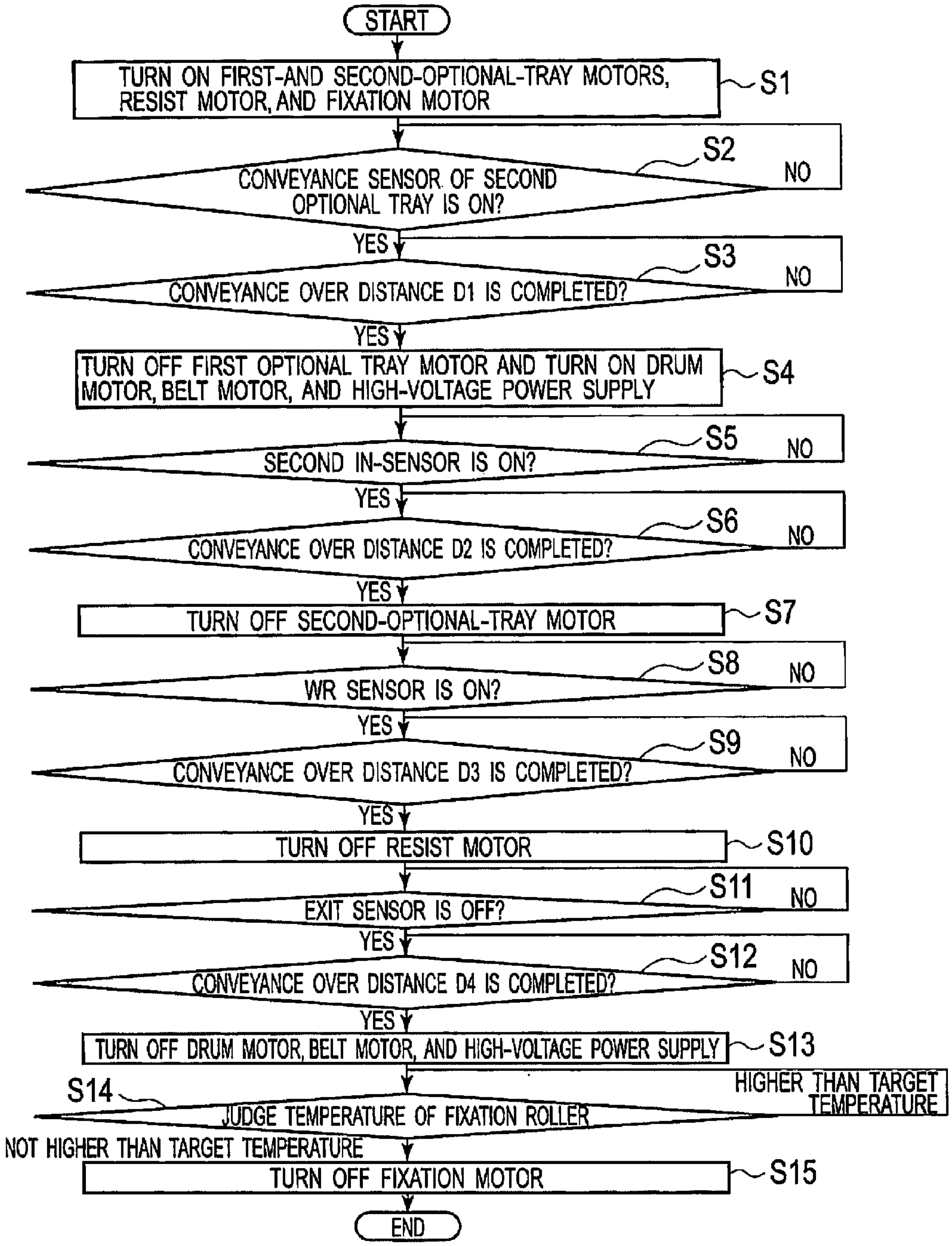


FIG. 6

TIME CHART OF IMAGE FORMATION APPARATUS IN FIRST EMBODIMENT

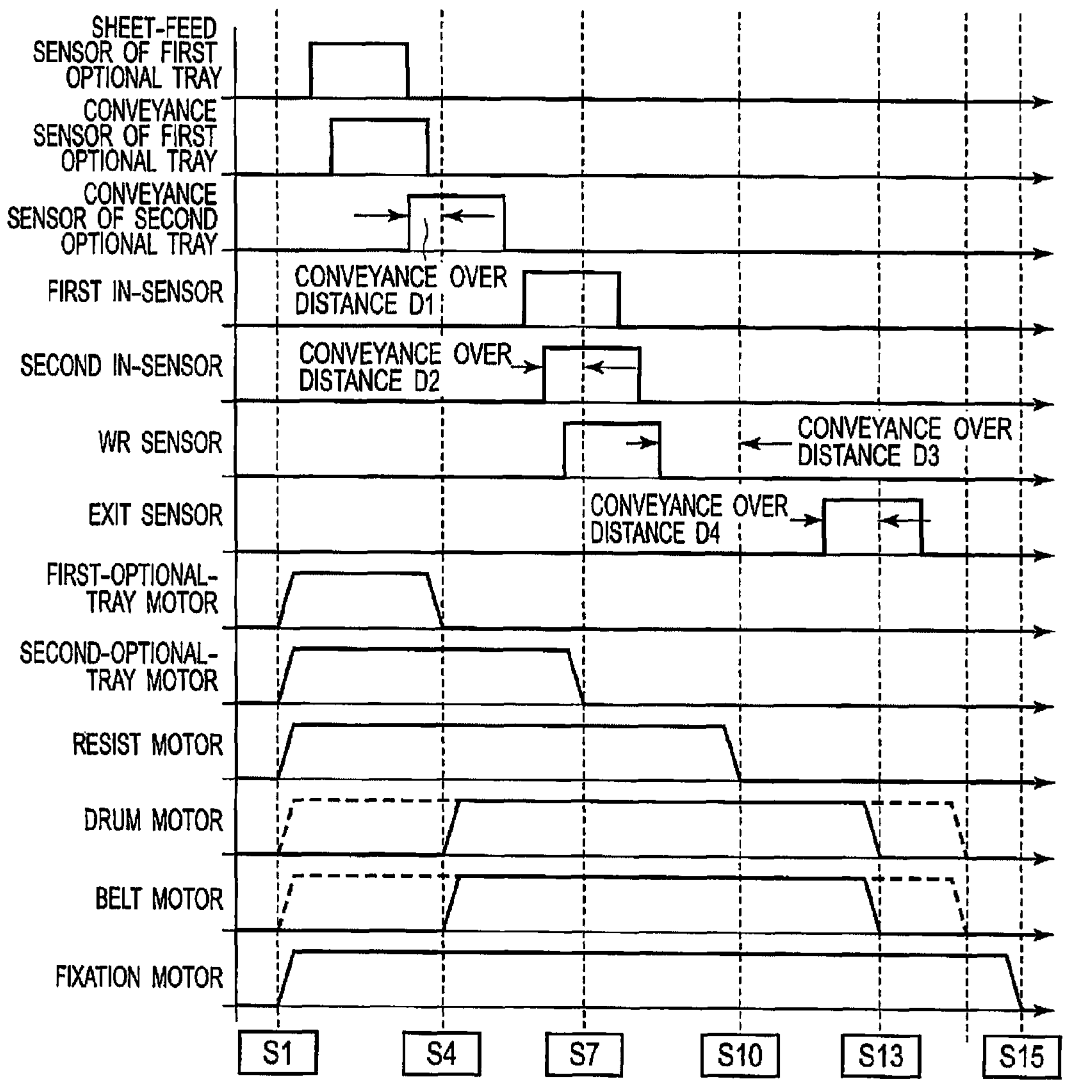


FIG. 7

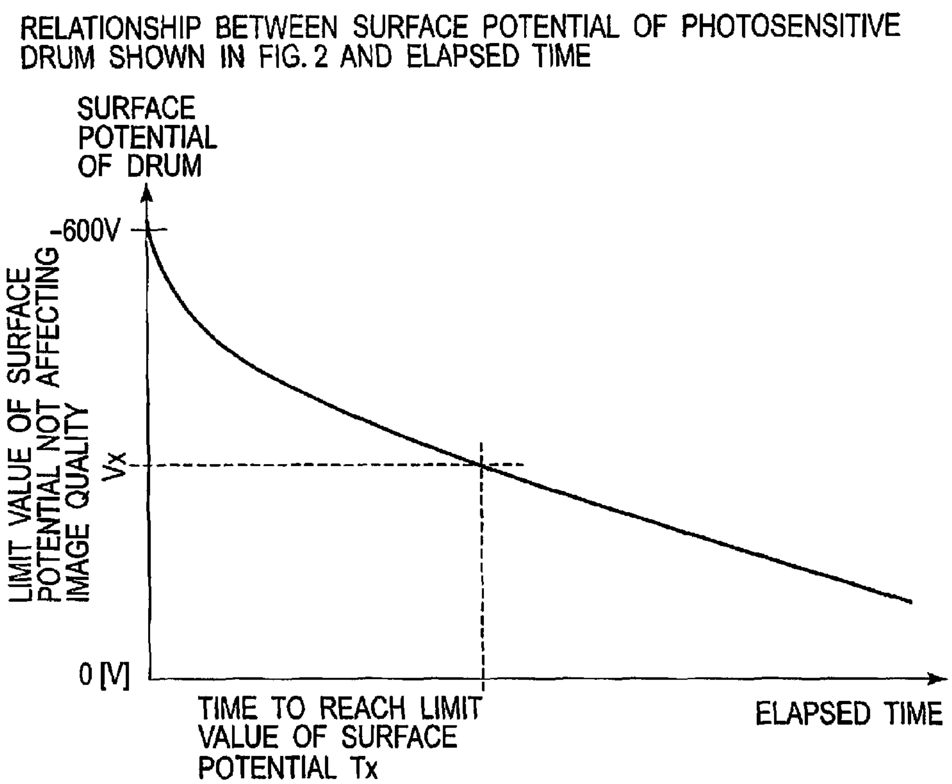

RELATIONSHIP BETWEEN SURFACE POTENTIAL OF PHOTOSENSITIVE DRUM SHOWN IN FIG. 2 AND ELAPSED TIME
SURFACE POTENTIAL OF DRUM
-600V
LIMIT VALUE OF SURFACE POTENTIAL NOT AFFECTING IMAGE QUALITY Vx
0 [V]
TIME TO REACH LIMIT VALUE OF SURFACE POTENTIAL Tx
ELAPSED TIME

FIG. 8 FLOWCHART (PART 1) OF IMAGE FORMATION APPARATUS IN SECOND EMBODIMENT

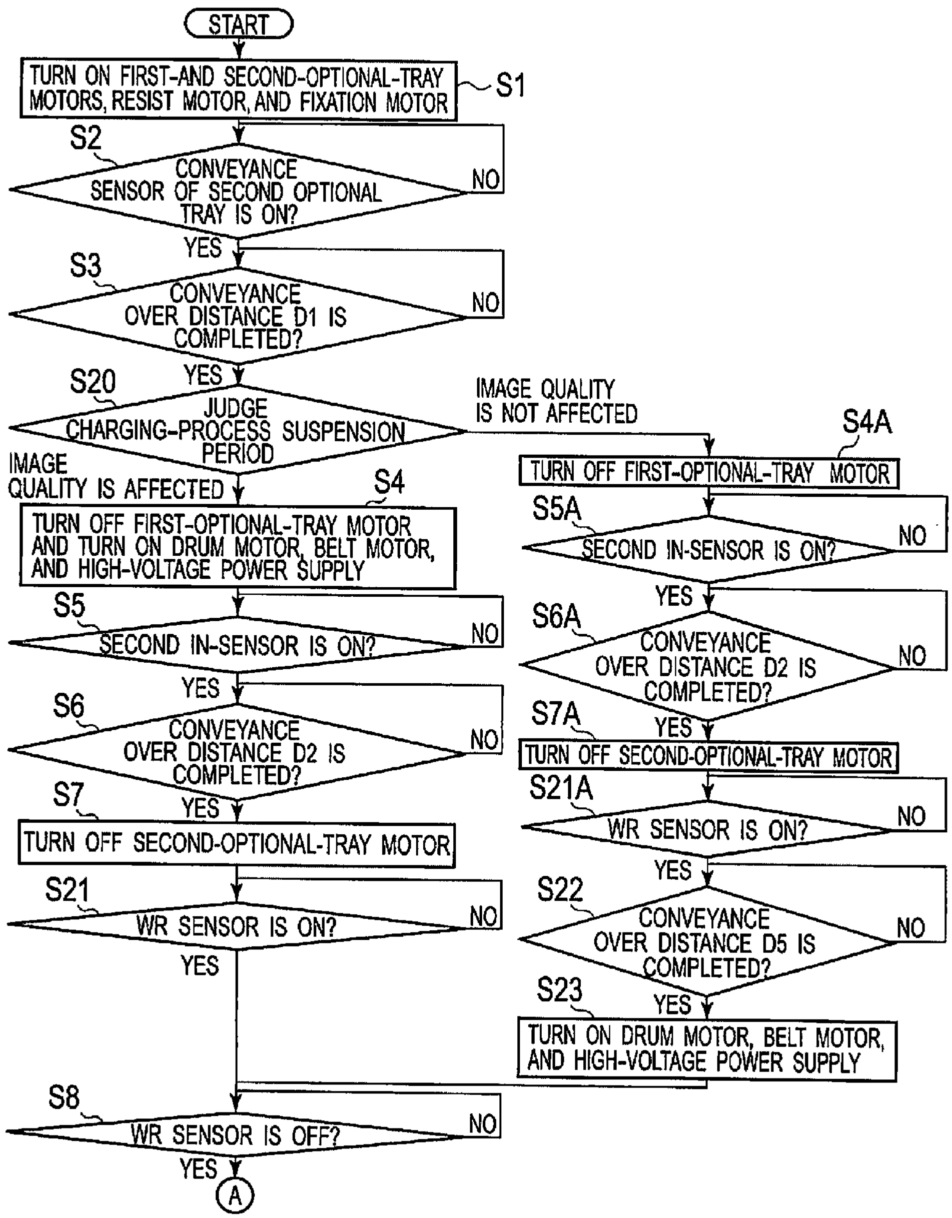


FIG. 9

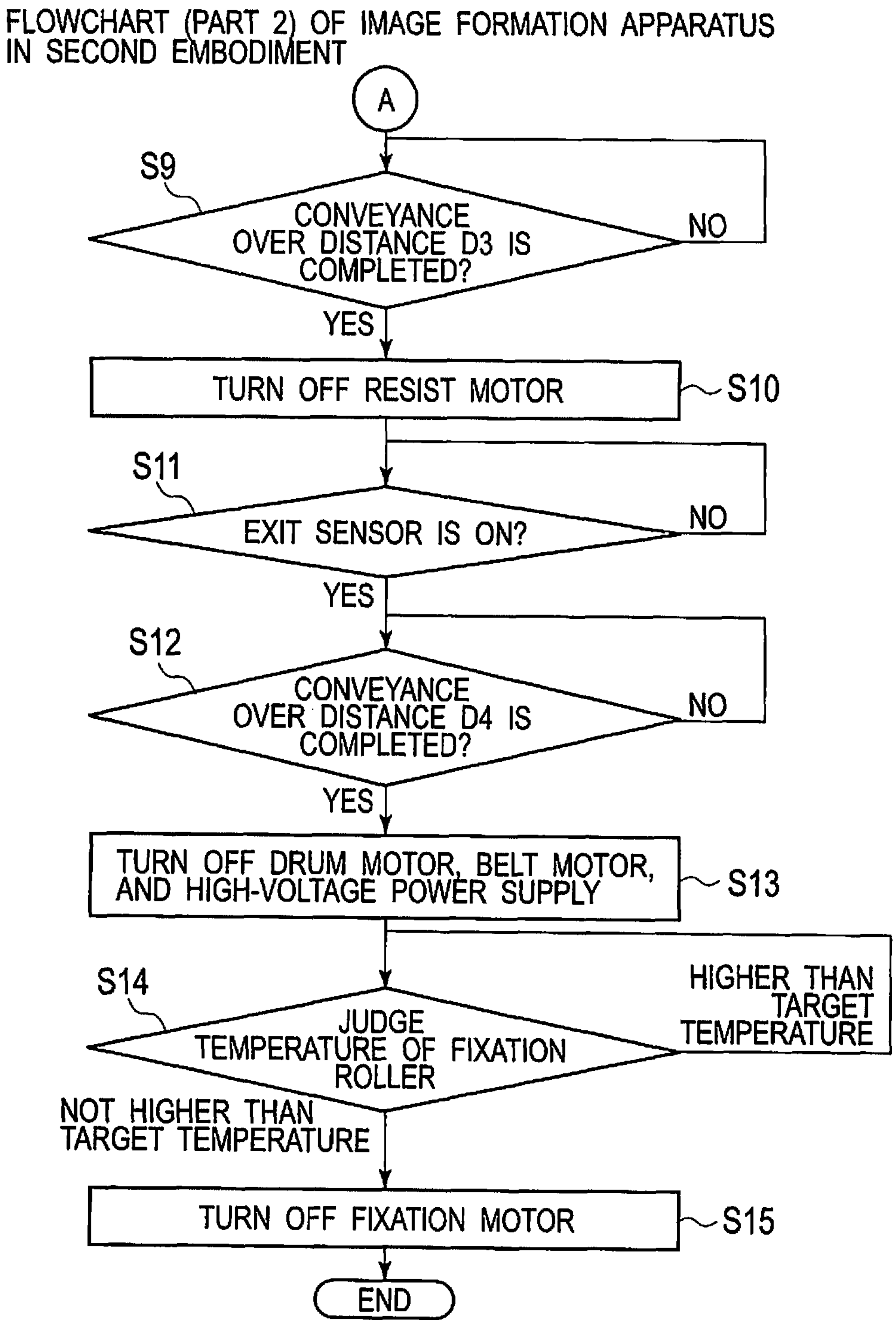

FLOWCHART (PART 2) OF IMAGE FORMATION APPARATUS IN SECOND EMBODIMENT
A
S9
CONVEYANCE OVER DISTANCE D3 IS COMPLETED?
NO
YES
TURN OFF RESIST MOTOR
S10
S11
EXIT SENSOR IS ON?
NO
YES
S12
CONVEYANCE OVER DISTANCE D4 IS COMPLETED?
NO
YES
TURN OFF DRUM MOTOR, BELT MOTOR, AND HIGH-VOLTAGE POWER SUPPLY
S13
S14
JUDGE TEMPERATURE OF FIXATION ROLLER
HIGHER THAN TARGET TEMPERATURE
NOT HIGHER THAN TARGET TEMPERATURE
TURN OFF FIXATION MOTOR
S15
END

FIG. 10

TIME CHART OF IMAGE FORMATION APPARATUS IN SECOND EMBODIMENT

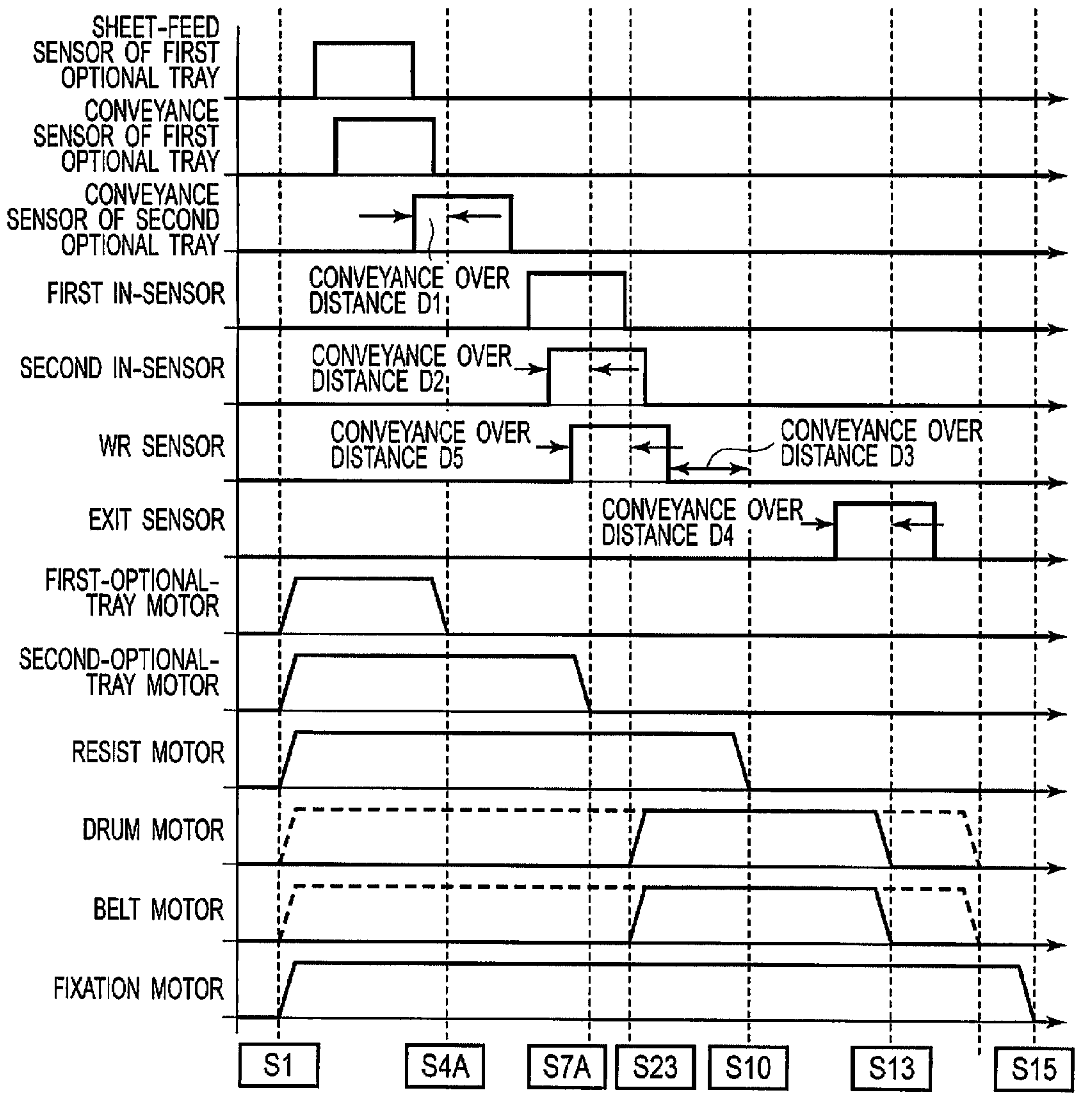


FIG. 11

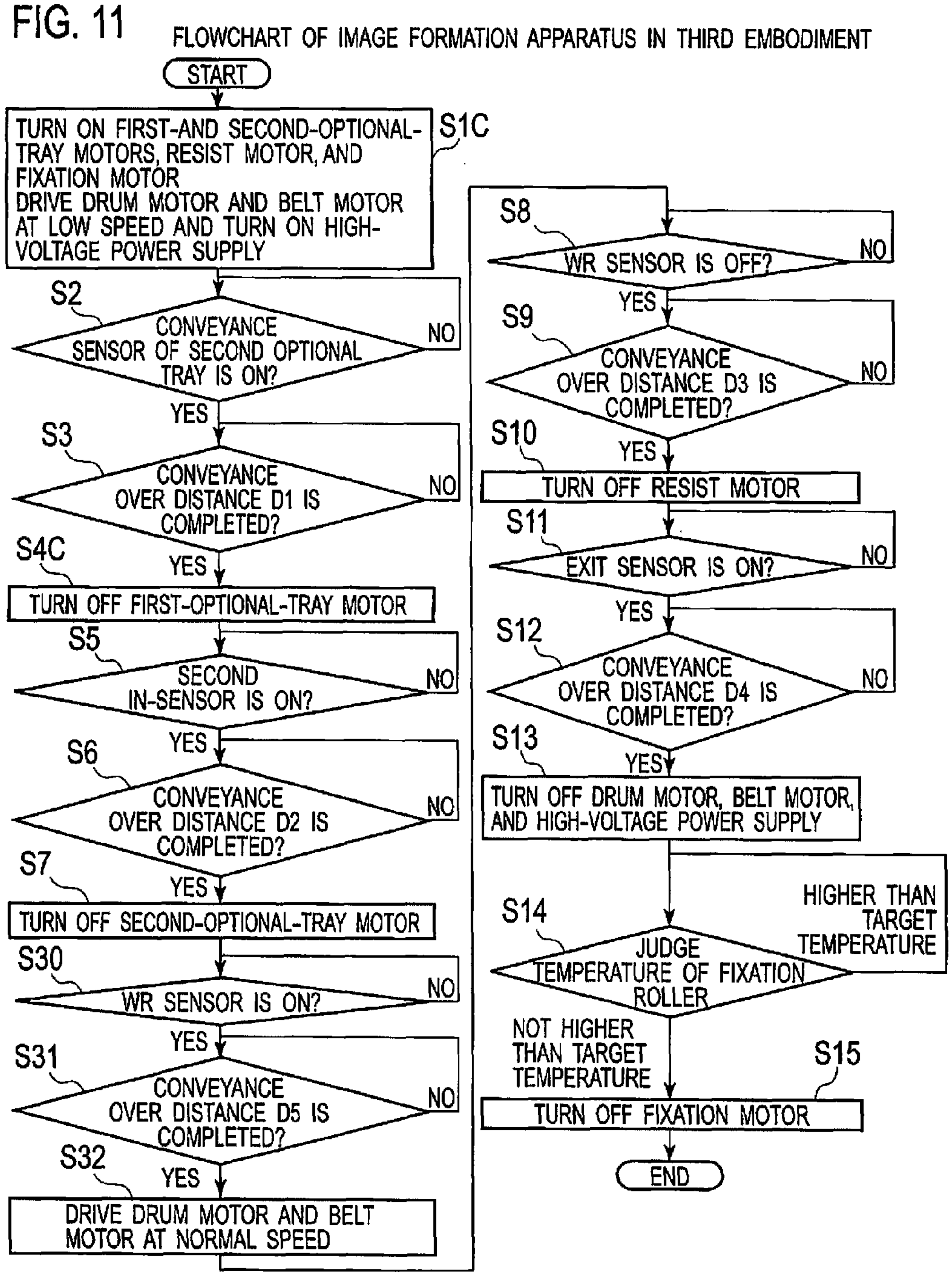

FLOWCHART OF IMAGE FORMATION APPARATUS IN THIRD EMBODIMENT
START
S1C
TURN ON FIRST-AND SECOND-OPTIONAL-TRAY MOTORS, RESIST MOTOR, AND FIXATION MOTOR
DRIVE DRUM MOTOR AND BELT MOTOR AT LOW SPEED AND TURN ON HIGH-VOLTAGE POWER SUPPLY
S2
CONVEYANCE SENSOR OF SECOND OPTIONAL TRAY IS ON?
NO
YES
S3
CONVEYANCE OVER DISTANCE D1 IS COMPLETED?
NO
YES
S4C
TURN OFF FIRST-OPTIONAL-TRAY MOTOR
S5
SECOND IN-SENSOR IS ON?
NO
YES
S6
CONVEYANCE OVER DISTANCE D2 IS COMPLETED?
NO
YES
S7
TURN OFF SECOND-OPTIONAL-TRAY MOTOR
S30
WR SENSOR IS ON?
NO
YES
S31
CONVEYANCE OVER DISTANCE D5 IS COMPLETED?
NO
YES
S32
DRIVE DRUM MOTOR AND BELT MOTOR AT NORMAL SPEED
S8
WR SENSOR IS OFF?
NO
YES
S9
CONVEYANCE OVER DISTANCE D3 IS COMPLETED?
NO
YES
S10
TURN OFF RESIST MOTOR
S11
EXIT SENSOR IS ON?
NO
YES
S12
CONVEYANCE OVER DISTANCE D4 IS COMPLETED?
NO
YES
S13
TURN OFF DRUM MOTOR, BELT MOTOR, AND HIGH-VOLTAGE POWER SUPPLY
S14
JUDGE TEMPERATURE OF FIXATION ROLLER
HIGHER THAN TARGET TEMPERATURE
NOT HIGHER THAN TARGET TEMPERATURE
S15
TURN OFF FIXATION MOTOR
END

FIG. 12

TIME CHART OF IMAGE FORMATION APPARATUS IN THIRD EMBODIMENT

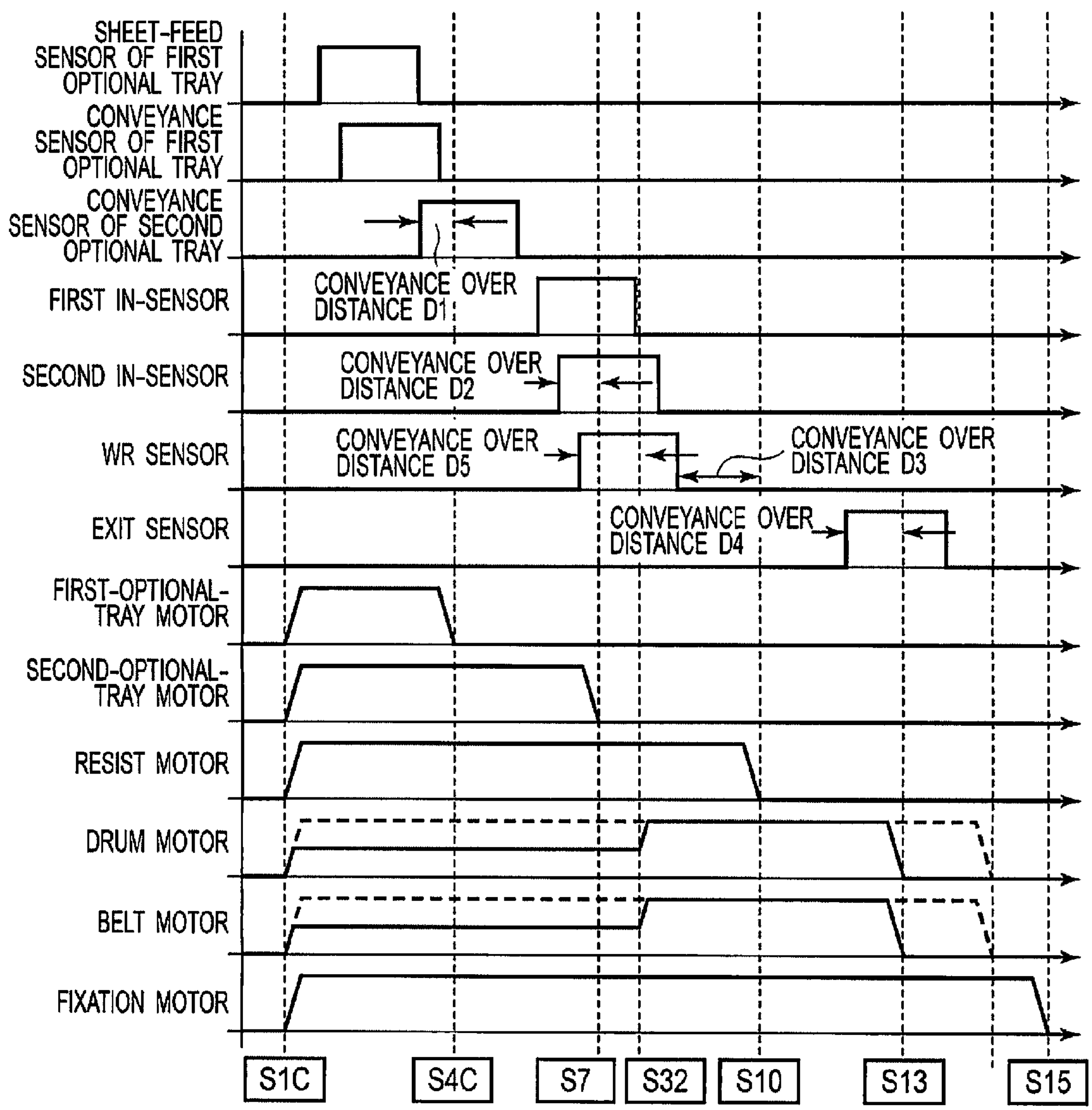


FIG. 13

FLOWCHART OF IMAGE FORMATION APPARATUS IN FOURTH EMBODIMENT

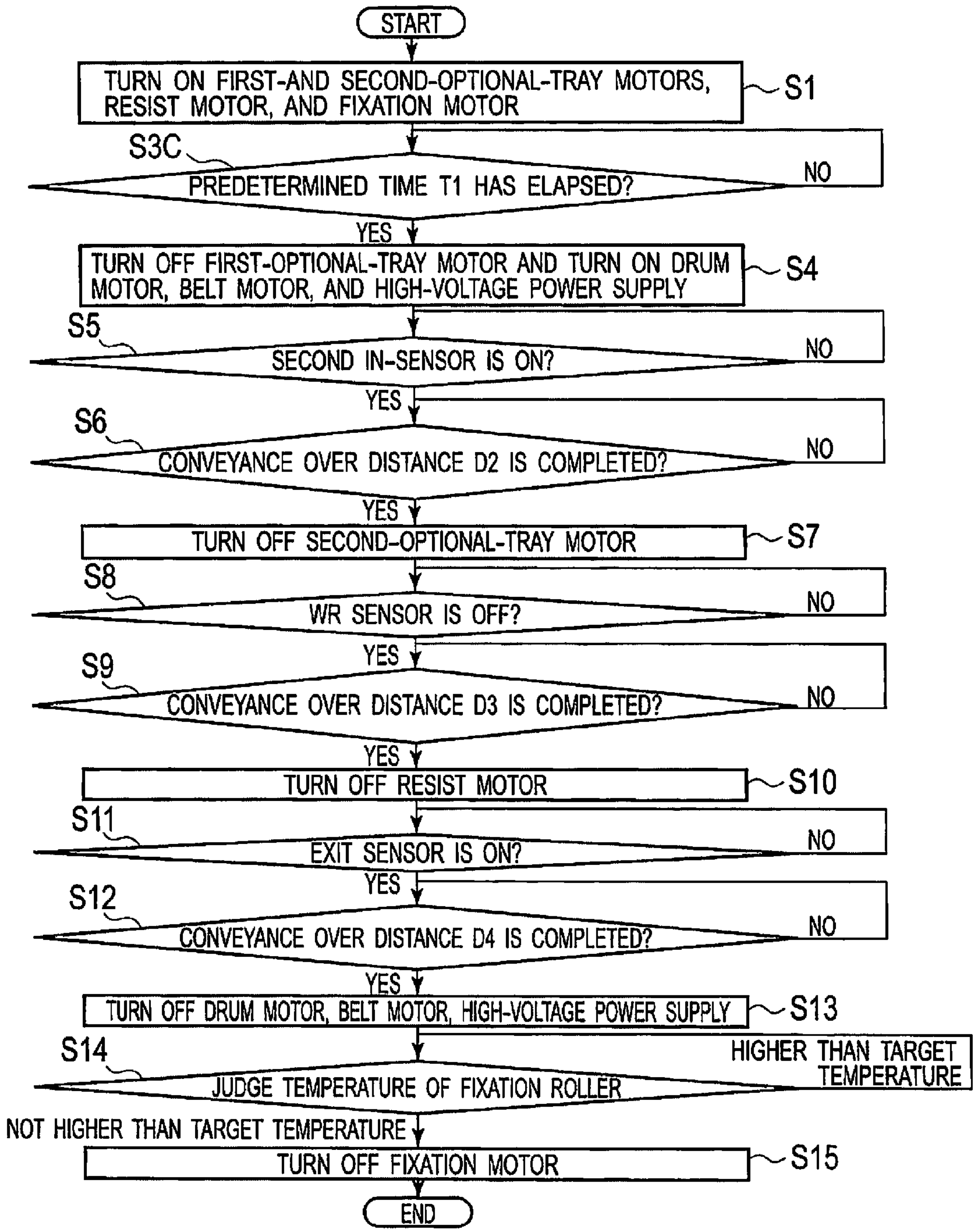
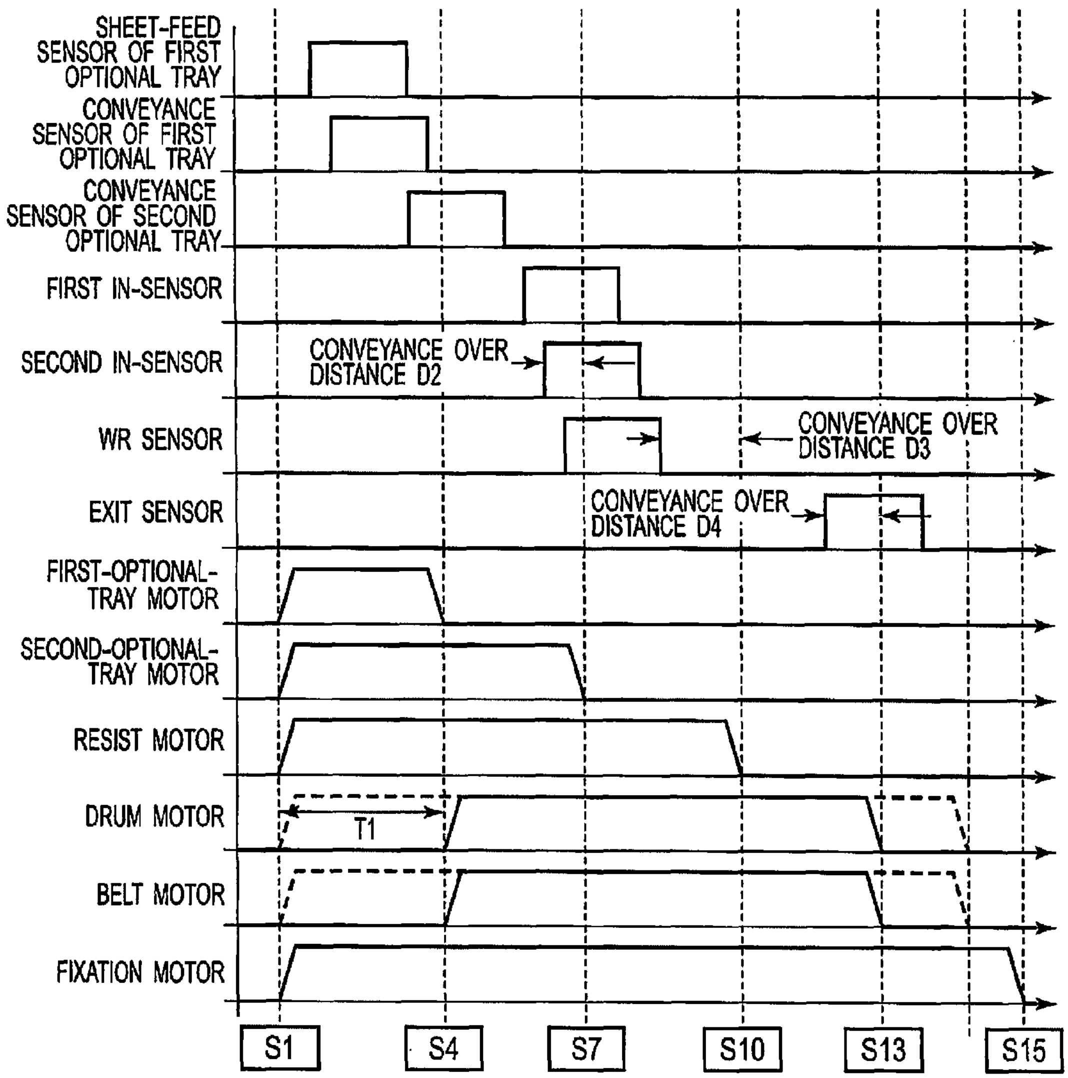


FIG. 14

TIME CHART OF IMAGE FORMATION APPARATUS IN FOURTH EMBODIMENT



# IMAGE FORMATION APPARATUS

## CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuing application of application Ser. No. 13/354,865 filed on Jan. 20, 2012, which is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2011-016101 filed on Jan. 28, 2011, entitled "IMAGE FORMATION APPARATUS", the entire contents of which are incorporated herein by reference.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present disclosure relates to an image formation apparatus of electrophotography or the like.

2. Description of Related Art

A conventional image formation apparatus transfers a toner image as a developer image to a sheet as a medium by means of a photosensitive drum as an image carrier and an image transfer roller as an image transfer device as disclosed, for example, in Japanese Patent Application Laid-open No. 2006-124058.

## SUMMARY OF THE INVENTION

The conventional image formation apparatus, however, starts driving the photosensitive drum or the image transfer roller at the same time as the feeding of a sheet from a sheet feeder cassette. Accordingly, the photosensitive drum or the image transfer roller of the conventional image formation apparatus, in some cases, lacks a sufficient service life.

An aspect of the invention is an image formation apparatus including: an image carrier on which a developer image is to be formed; an image transfer device configured to transfer the developer image formed on the image carrier to a medium at an image transfer position; a controller configured to control drive of the image carrier and the image transfer device; a first medium feeder configured to feed the medium to the image transfer position along a medium conveyance path extending from the first medium feeder to the image transfer position; and a medium detector provided between the first medium feeder and the image transfer position in the medium conveyance path. The controller is configured to control the drive of the image carrier on the basis of a medium-detection result by the medium detector.

Another aspect of the invention is an image formation apparatus including: an image carrier on which a developer image is formed; an image transfer device configured to transfer the developer image formed on the image carrier to a medium; a controller configured to control drive of the image carrier and the image transfer device; a first medium feeder configured to feed the medium in the medium-conveyance direction to convey the medium to the image transfer device; a medium-size detector configured to detect a conveyance-direction dimension of the medium; and a leading-end detector provided at a first distance from the image transfer device in a downstream direction and configured to detect the leading end of the medium discharged from the image transfer device. The controller is configured to stop driving the image carrier when the medium is conveyed over a distance determined by subtracting the first distance from the conveyance-direction dimension after the leading-end detector detects the leading end of the medium.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram illustrating the configuration of an image formation apparatus according to a first embodiment of the invention.

FIG. **2** is a schematic diagram illustrating the configuration of an image formation unit of the image formation apparatus shown in FIG. **1**.

FIG. **3** is a diagram illustrating the circuit configuration of the image formation apparatus shown in FIG. **1**.

FIG. **4** is a diagram illustrating the circuit configuration of an optional tray of the image formation apparatus shown in FIG. **1**.

FIG. **5** is a flowchart illustrating the operations of the image formation apparatus according to the first embodiment of the invention.

FIG. **6** is a time chart illustrating the operations of the image formation apparatus according to the first embodiment of the invention.

FIG. **7** is a chart illustrating the relationship between the surface potential of a photosensitive drum shown in FIG. **2** and the elapsed time.

FIG. **8** is a flowchart (Part 1) illustrating the operations of an image formation apparatus according to a second embodiment of the invention.

FIG. **9** is a flowchart (Part 2) illustrating the operations of an image formation apparatus according to the second embodiment of the invention.

FIG. **10** is a time chart illustrating the operations of the image formation apparatus according to the second embodiment of the invention.

FIG. **11** is a flowchart illustrating the operations of the image formation apparatus according to a third embodiment of the invention.

FIG. **12** is a time chart illustrating the operations of the image formation apparatus according to the third embodiment of the invention.

FIG. **13** is a flowchart illustrating the operations of the image formation apparatus according to a fourth embodiment of the invention.

FIG. **14** is a time chart illustrating the operations of the image formation apparatus according to the fourth embodiment of the invention.

## DETAILED DESCRIPTION OF EMBODIMENTS

Descriptions are provided hereinbelow for embodiments based on the drawings. In the respective drawings referenced herein, the same constituents are designated by the same reference numerals and duplicate explanation concerning the same constituents is omitted. All of the drawings illustrate the respective examples only.

### First Embodiment

### Configuration of First Embodiment

FIG. **1** is a schematic diagram illustrating the configuration of image formation apparatus **10** according to a first embodiment of the invention.

Image formation apparatus **10** is a printer of a tandem type. Image formation apparatus **10** includes a main body including medium feeder F, as well as first optional tray **11-3** and second optional tray **11-2** that are additionally provided to the image formation apparatus main body. Thus, medium feeders of image formation apparatus **10** include: medium feeder F as a third medium feeder that image formation apparatus **10** is originally equipped with and provided in a bottom portion of the main body of image formation apparatus **10**; second optional tray **11-2** as a second medium feeder that is additionally provided below medium feeder F of the image formation apparatus main body; and first optional tray **11-3** as a first medium feeder that is additionally provided below second optional tray **11-2**.

The main body of image formation apparatus **10** includes medium feeder F, image formation section **20**, fixation unit **40**, discharger unit **50**, and stacker **55** or face-up stacker **56**. Medium feeder F is configured to feed print medium **100**, which may be a recording sheet. Image formation section **20** is configured to form a toner image as a developer image. Fixation unit **40** is configured to fix the toner image to a surface of print medium **100**. Discharger unit **50** is configured to discharge print medium **100**. Stacker **55** or face-up stacker **56** is configured to contain discharged print medium **100**. In addition, image formation apparatus **10** includes various motors that are configured to rotate the rollers and the like (described later) and various clutches configured to turn ON and OFF the transmission of power to the rollers provided in a medium conveyance path. Furthermore, image formation apparatus **10** includes high-voltage power supply **63** and a low-voltage power supply. High-voltage power supply **63** shown in FIG. **3** and described later supplies high voltages ranging from 200V to 5000V to charger roller **24**, image transfer roller **21**, and the like in image formation unit **22**. The low-voltage power supply supplies DC electric power with voltages of 5 V, 24 V, and the like to the circuits and motors.

Medium feeder F of the image formation apparatus main body is detachably set in a lower portion of the main body of image formation apparatus **10**. Medium feeder F includes sheet cassette **110-1**, pick-up roller **12-1**, sheet-feeder roller **13-1**, sheet-feed sensor **14-1**, first IN-sensor **15-1**, second IN-sensor **17**, WR sensor **19**, first resist-roller pair **16-1**, and second resist-roller pair **18**. Sheet cassette **110-1** as a medium storage detachably set in a lower portion of the main body of image formation apparatus **10** is capable of storing print media **100** therein. Pick-up roller **12-1** works together with a blade-shaped separator or the like to pick up print media **100** one by one from sheet cassette **110-1**. Sheet-feeder roller **13-1** is configured to feed print medium **100** thus taken out of the sheet cassette **110-1**. Sheet-feed sensor **14-1** is configured to judge whether print medium **100** is fed. First IN-sensor **15-1**, second IN-sensor **17**, and WR sensor **19** are configured to judge the position of print medium **100**. First resist-roller pair **16-1** and second resist-roller pair **18** are configured to convey print media **100** to image formation section **20**.

Second optional tray **11-2** as a second medium feeder, includes sheet cassette **110-2**, pick-up roller **12-2**, sheet-feeder roller **13-2**, sheet-feed sensor **14-2**, conveyance sensor **15-2**, and conveyance rollers **16-2**. Sheet cassette **110-2** as a medium storage is capable of storing print media **100** therein. Pick-up roller **12-2** works together with a blade-shaped separator to pick up print media **100** one by one from sheet cassette **110-2**. Sheet-feeder roller **13-2** is configured to feed print medium **100** thus taken out of the sheet cassette **110-2**. Sheet-feed sensor **14-2** is configured to judge whether print medium **100** is fed. Conveyance sensor **15-2** is configured to judge the position of print medium **100**. Conveyance rollers **16-2** are configured to convey print medium **100** to image formation apparatus **10**.

First optional tray **11-3** (serving as a first medium feeder) has a configuration that is similar to the configuration of second optional tray **11-2**.

Each of sheet cassettes **110** (=**110-1** to **110-3**) can store a plurality of print media **100** therein. Print media **100** is used to print either monochrome or color images, and have various predetermined sizes. For example, print media **100** is a sheet of high-quality paper, recycled paper, gloss paper, or matte paper. In addition, an OHP (over head projector) film may also be used as print media **100**.

Pick-up rollers **12** (=**12-1** to **12-3**) are provided respectively in medium feeder F of the main body of image formation apparatus **10**, in second optional tray **11-2**, and in first optional tray **11-3**. Each pick-up roller **12** is capable of rotating while being pressed onto the top surface of the stacked print media **100**. In the medium conveyance path, sheet-feeder rollers **13** (=**13-1** to **13-3**) are provided downstream of their corresponding pick-up rollers **12** (=**12-1** to **12-3**). In addition, sheet-feed sensors **14** (=**14-1** to **14-3**) are provided downstream of their corresponding sheet-feeder rollers **13** (=**13-1** to **13-3**).

Inside the medium feeder F, first IN-sensor **15-1** is provided downstream of sheet-feed sensor **14-1** along the medium conveyance path in a manner that first IN-sensor **15-1** can detect print medium **100**. Downstream of first IN-sensor **15-1**, first resist-roller pair **16-1**, second IN-sensor **17**, second resist-roller pair **18**, and WR sensor **19** are provided in this order.

Inside second optional tray **11-2**, which is provided at the upstream side of medium feeder F, conveyance sensor **15-2** is provided downstream of sheet-feed sensor **14-2** along the medium conveyance path in a manner that conveyance sensor **15-2** can detect print medium **100**. In the medium conveyance route, conveyance sensor **15-2** is provided at a substantially linear section of the medium conveyance path where print medium **100** is conveyed stably. Conveyance rollers **16-2** are provided downstream of conveyance sensor **15-2**. Conveyance rollers **16-2** of second optional tray **11-2** convey print medium **100** towards image formation section **20** through medium feeder F of the main body of image formation apparatus **10**. To put it differently, the downstream side of conveyance rollers **16-2** of second optional tray **11-2** is connected to an upstream-side position of first IN-sensor **15-1** and first resist-roller pair **16-1** provided in medium feeder F of the main body of image formation apparatus **10**.

Conveyance sensor **15-3** is provided along the medium conveyance path in the first optional tray **11-3** and downstream of sheet-feed sensor **14-3** in a manner that conveyance sensor **15-3** can detect print medium **100**. Conveyance rollers **16-3** are provided downstream of the conveyance sensor **15-3**. Conveyance rollers **16-3** convey print medium **100** via conveyance sensor **15-2** and conveyance rollers **16-2** provided in second optional tray **11-2** to the position of first IN-sensor **15-1** and first resist-roller pair **16-1** provided in medium feeder F of the main body of image formation apparatus **10**.

Image formation section **20** of the main body of image formation apparatus **10** includes four image formation units **22** (=**22-1** to **22-4**) arranged in the order of black (K), yellow (Y), magenta (M), and cyan (C) from the left hand side of FIG. **1**. Image formation section **20** also includes image transfer rollers **21** (=**21-1** to **21-4**) respectively including photosensitive drums **23-1** to **23-4** provided therebelow. Medium conveyance mechanism **30** is provided below image formation section **20**. Medium conveyance mechanism **30** includes driven roller **32**, belt drive roller **33**, and conveyor belt **31** for medium conveyance wound across driven roller **32** and belt drive roller **33**. Belt drive roller **33** is configured to drive conveyor belt **31**. Driven roller **32**, on the other hand, rotates along with the rotation of conveyor belt **31** and rotates conveyor belt **31**.

Each of four image formation units **22** respectively corresponding to black (K), yellow (Y), magenta (M), and cyan (C) includes photosensitive drum **23**, charger roller **24**, light-emitting diode (hereinafter referred to as LED) head **25**, development roller **26**, developer supply roller **27**, developer storage cartridge **29**, an unillustrated toner regulation member, and cleaning blade **28**. Photosensitive drum **23** is configured to carry an electrostatic latent image based on image information. Charger roller **24** is configured to charge photosensitive drum **23**. LED head **25** is configured to irradiate the surface of photosensitive drum **23** with light based on the image information. Development roller **26** is configured to develop the electrostatic latent image on the photosensitive drum **2** by using toner as the developer. Developer supply roller **27** is configured to supply the toner to development roller **26**. Developer storage cartridge **29** can be detachably set in image formation unit **22**. Cleaning blade **28** shown in FIG. **2** (described in detail later) is configured to scrape off the toner remaining on the surface of the photosensitive drum **23**. Between each of photosensitive drums **23** (=**23-1** to **23-4**) and the corresponding one of image transfer rollers (=**21-1** to **21-4**), the upper line of conveyor belt **31** of medium conveyance mechanism **30** and is in contact with the image carriers and with the image transfer devices. Conveyor belt **31** rotates to convey print medium **100** to the nip portions between photosensitive drums **23** (=**23-1** to **23-4**) and image transfer rollers **21** (=**21-1** to **21-4**) one after another. Image formation section **20** serves as a development device configured to develop toner image on print medium **100**.

Fixation unit **40** includes fixation roller **41**, back-up roller **42**, and heater **43**. Heater **43**, which is provided in fixation roller **41**, is a halogen lamp or the like. Fixation unit **40** serving as a fixation device is configured to apply heat and pressure to print medium **100**, thereby fixing the toner image.

Discharger unit **50** includes EXIT sensor **51** as a leading-end detector and pairs of discharger rollers **52** to **54**. EXIT sensor **51** is positioned downstream of image formation unit **22-4** provided on the most downstream side among the four image formation units **22** in the image formation section **20**. EXIT sensor **51** and image formation unit **22-4** are separated away from each other by a first distance. EXIT sensor **51** thus positioned detects discharge of print medium **100** from image formation section **20**. Pairs of discharger rollers **52** to **54** are provided downstream of fixation unit **40** along the medium conveyance path so as to nip print medium **100**. Unillustrated motors drive these pairs of discharger rollers **52** to **54**.

Incidentally, point P between conveyance rollers **16-2** and first IN-sensor **15-1** in FIG. **1** is the most downstream position of print medium **100** in a zone that allows the toner-image transfer at image transfer position B to be performed in time. To put it differently, point P is located immediately before a zone that does not allow any more the toner-image transfer at image transfer position B to be performed in time. Hence, if the image formation process to form a toner image on the surface of photosensitive drums **23-1** is started while print medium **100** is being conveyed on the downstream side of this point P in the medium conveyance path, the toner image fails to reach image transfer position B in time for the arrival of print medium **100** at image transfer position B. This means that the toner image fails to get ready for the toner-image transfer operation that occurs at image transfer position B. In contrast, if the image formation process to form a toner image is started while print medium **100** is still being conveyed at the upstream side of this point P in the medium conveyance path, the arrival of the toner image at image transfer position B can be synchronized with the arrival of print medium **100** at image transfer position B. This means that the toner image is ready for the toner-image transfer operation to be performed at image transfer position B.

When distance L**2** shown in FIG. **1** represents the distance between point P and the most upstream image transfer position B (i.e., nip B between the most upstream photosensitive drum **23-1** and the most upstream image transfer roller **21-1**), and distance L**1** represents the distance between the most upstream image transfer position B (the most upstream nip B) and contact point A where pick-up roller **12-1** of medium feeder F is in contact with print medium **100**, preferably, L**1**=L**2**.

FIG. **2** is a schematic diagram illustrating the configuration of image formation unit **22** of image formation apparatus **10** shown in FIG. **1**.

Each of image formation units **22** includes photosensitive drum **23**, charger roller **24**, LED head **25**, development roller **26**, supply roller **27**, developer storage cartridge **29**, and cleaning blade **28**. Charger roller **24** is pressed onto photosensitive drum **23**. LED head **25** is provided above photosensitive drum **23**. Development roller **26** contacts photosensitive drum **23**. Supply roller **27** is in contact with development roller **26**. Developer storage cartridge **29** is provided above supply roller **27**. Cleaning blade **28** contacts the surface of photosensitive drum **23**.

Photosensitive drum **23** includes a conductive base layer made of aluminum or the like. Photosensitive drum **23** also includes a photosensitive layer formed on the conductive base layer and including a photoconductive layer and a charge transportation layer. Photosensitive drum **23** has a cylindrical shape, and is supported rotatably. Photosensitive drum **23** is in contact with charger roller **24**, with image transfer roller **21**, and with development roller **26**. In addition, the leading end portion of cleaning blade **28** contacts the photosensitive drum **23**. Electrical charges are accumulated on the surface of the photosensitive drum **23**, and thereby photosensitive drum **23** serves as an image carrier that is configured to carry a toner image. Photosensitive drum **23** rotates anticlockwise in FIG. **2**. Components of each image formation unit **22** are described below in an order of the rotation of photosensitive drum **23**.

Charger roller **24** is made of a conductive metal shaft coated with a semiconductor rubber such as silicone rubber, has a cylindrical shape, is supported rotatably, and is pressed onto photosensitive drum **23**. Charger roller **24** is electrically charged by high-voltage power supply **63** shown in FIG. **3** and described later. Charger roller **24** rotates while being pressed onto photosensitive drum **23**, and thereby applies a predetermined voltage to photosensitive drum **23**. Consequently, the surface of photosensitive drum **23** accumulates electrical charges uniformly.

LED head **25** includes LEDs, a lens array, and an LED driver element and is provided above photosensitive drum **23**. LED head **25** radiates light based on the image information onto the surface of photosensitive drum **23**, and thereby serves as a light-exposure device that is configured to form an electrostatic latent image on the surface of the photosensitive drum **23**.

Supply roller **27** is made of a conductive metal shaft coated with rubber. Supply roller **27** has a cylindrical shape and is in contact with development roller **26**. Supply roller **27** is electrically charged by high-voltage power supply **63** shown in FIG. **3** and described later. Supply roller **27** is pressed onto development roller **26**, and thereby supplies toner to development roller **26**.

Development roller **26** is made of a conductive metal shaft coated with a semiconductor urethane rubber material or the like and has a cylindrical shape. Development roller **26** is in contact with photosensitive drum **23** and the leading end portion of the unillustrated toner regulation member at the circumferential surface. Development roller **26** is electrically charged by high-voltage power supply **63** shown in FIG. **3** and described later. Development roller **26** is pressed onto supply roller **27**, and thereby toner is supplied to the developer roller **26**.

The unillustrated toner regulation member is made of stainless steel or the like and has a plate shape. The toner regulation member has a leading end portion that contacts the surface of development roller **26**. The toner regulation member scrapes off the excess portion of a predetermined amount of the toner on the surface of development roller **26**. Thus, the toner regulation member regulates the thickness of the toner on the surface of the development roller **26** in a manner that a toner layer with a uniform thickness can always be formed on the surface of the development roller **26**.

Cleaning blade **28** is made of a rubber material or the like and has a plate shape. Cleaning blade **28** is provided so that the leading end portion of cleaning blade **28** contacts the surface of photosensitive drum **23**. After the toner image formed on the surface of photosensitive drum **23** is transferred to the surface of print medium **100**, cleaning blade **28** cleans the surface of photosensitive drum **23** by scraping off the toner remaining on the surface.

FIG. **3** is a diagram illustrating the circuit configuration of image formation apparatus **10** shown in FIG. **1**.

Image formation apparatus **10** includes controller **60**, image processor circuit **61** as a medium-size detector, display unit **62**, high-voltage power supply **63**, controller line **64**, read only memory (hereinafter abbreviated as "ROM") **65**, random access memory (hereinafter abbreviated as "RAM") **66**, non-volatile memory **67**, input-output port (hereinafter simply referred to as "I/O port") **68**, video processor circuit (hereinafter referred to as "VIDEO processor circuit") **69** including a counter, dynamic random access memory (hereinafter abbreviated as "DRAM") **70**, I/O port **71**, driver circuits **72** to **76**, heater driver circuit **77**, timer **78** as a charge-voltage judgment portion, optional tray interface circuit (hereinafter simply referred to as "optional tray IF circuit") **79**, sheet-feed sensor **14-1**, first IN-sensor **15-1**, second IN-sensor **17**, WR sensor **19**, EXIT sensor **51**, LED heads **25** (=**25-1** to **25-4**), heater **43**, sheet-feeder motor **91**, resist motor **93**, drum motor **94**, belt motor **95**, and fixation motor **96**.

Controller **60** is connected, via controller line **64**, to image processor circuit **61**, display unit **62**, high-voltage power supply **63**, ROM **65**, RAM **66**, non-volatile memory **67**, I/O port **68**, VIDEO processor circuit **69**, I/O port **71**, timer **78**, and optional tray IF circuit **79**.

I/O port **68** is connected to sheet-feed sensor **14-1**, first IN-sensor **15-1**, second IN-sensor **17**, WR sensor **19**, and EXIT sensor **51**. VIDEO processor circuit (counter) **69** is connected to LED heads **25** (=**25-1** to **25-4**) and DRAM **70**.

I/O port **71** is connected to sheet-feeder motor **91** via driver circuit **72**, and is also connected to resist motor **93** via driver circuit **73**. In addition, I/O port **71** is connected to drum motor **94** via driver circuit **74**, and is also connected to belt motor **95** via driver circuit **75**. Moreover, I/O port **71** is connected to fixation motor **96** via driver circuit **76**, and is also connected to heater **43** via heater driver circuit **77**.

Controller **60** is configured to entirely control image formation apparatus **10**. By monitoring the detection results of sensors **14**, **15**, **17**, **19**, and **51**, controller **60** controls the driving of, and the application of voltages to, rollers **12**, **13**, **16**, **18**, **52**, **53**, and **54**, as well as fixation unit **40**, photosensitive drum **23**, image transfer roller **21**, and conveyor belt **31**. In addition, controller **60** controls the image formation process. Image processor circuit **61** is configured to take in image data sent via control signal line **87** as a connection device from a host or an external image transfer apparatus that is connected to image formation apparatus **10** and convert the image data into a printable data format. Display unit **62** is configured to monitor the state of image formation apparatus **10**, and to prompt the user to take appropriate actions. ROM **65** is configured to store control programs that are necessary for the operation of this first embodiment. RAM **66** serves as a working memory for the control programs of this first embodiment. Non-volatile memory **67** is configured to store information which is needed for the control of this first embodiment and which must be kept even after image formation apparatus **10** is powered OFF.

I/O port **68** monitors the states of sheet-feed sensor **14-1**, first IN-sensor **15-1**, second IN-sensor **17**, WR sensor **19**, EXIT sensor **51**, and other unillustrated sensors. VIDEO processor circuit **69** is configured to output the image data that have been converted by image processor circuit **61** to LED heads **25** as the light-exposure devices. In addition, VIDEO processor circuit **69** is configured to count, by using DRAM **70**, the number of dots that are outputted (emitted) in the printing. DRAM **70** is configured to store temporarily the image data outputted by image processor circuit **61**.

I/O port **71** is configured to output, to driver circuits **72** to **76**, control signals that make these driver circuits **72** to **76** drive sheet-feeder motor **91**, resist motor **93**, belt motor **95**, drum motor **94**, and fixation motor **96**. I/O port **71** also outputs, to heater driver circuit **77**, a control for driving heater **43** of fixation unit **40**. Timer **78** is configured to perform timer processes that are necessary for the controls.

High-voltage power supply **63** is configured to output high-voltage signals that are necessary for image formation. High-voltage power supply **63** is configured to output voltages CH-**1** to CH-**4** applied respectively to charger rollers **24-1** to **24-4**, voltages DB-**1** to DB-**4** applied respectively to development rollers **26-1** to **26-4**, output voltages SB-**1** to SB-**4** applied respectively to supply rollers **27-1** to **27-4** and output voltages TR-**1** to TR-**4** applied respectively to image transfer rollers **21-1** to **21-4**. Optional tray IF circuit **79** is configured to communicate with each of optional trays **11** (first optional tray **11-3** and second optional tray **11-2** in this embodiment) shown in FIG. **4** and described later.

FIG. **4** is a diagram illustrating the circuit configuration of optional tray **11** of image formation apparatus **10** shown in FIG. **1**.

Each of optional trays **11** (first optional tray **11-3** and second optional tray **11-2** in first embodiment) includes optional tray controller **80**, main board interface circuit (herein after, simply referred to as "main board IF circuit") **81**, optional tray ROM **82**, RAM **83**, I/O ports **84** and **85**, driver circuit **86**, sheet-feed sensor **14** (**14-2** or **14-3**), conveyance sensor **15** (**15-2** or **15-3**), tray motor **92**, and control signal line **87**.

Optional tray controller **80** is connected, via control signal line **87**, to main board IF circuit **81**, optional tray ROM **82**, and I/O ports **84** and **85**. I/O port **84** is connected to sheet-feed sensor **14** and conveyance sensor **15**. I/O port **85** is connected to tray motor **92** via driver circuit **86**.

Optional tray controller **80** is configured to perform overall control of optional tray **11**. Main board IF circuit **81** is communicably connected to optional tray IF circuit **79** of image formation apparatus **10**.

Optional tray ROM **82** is configured to store programs that are used to control optional tray **11**. I/O port **84** is configured to monitor sheet-feed sensor **14** and conveyance sensor **15** in optional tray **11**. I/O port **85** is configured to output, to driver circuit **86**, control signals for driving tray motor **92**.

A circuit board of optional tray **11** is mounted in each of second and first optional trays **11-2** and **11-3**. The circuit boards of second and first optional trays **11-2** and **11-3** are capable of communicating individually with controller **60** of the main body of image formation apparatus **10**.

(Operations of Comparative Example: Case of Using Medium Feeder F of Image Formation Apparatus Main Body)

By referring to FIG. **1**, description is given of the operations of a comparative example of a case where print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10**.

Print medium **100** is conveyed from the upstream side to the downstream side along the medium conveyance path. Sheet cassette **110-3** is located at the upstream end of the medium conveyance path whereas stacker **55** is located at the downstream end of the medium conveyance path.

Image formation apparatus **10** is connected to a host computer or an external apparatus (not illustrated) via a cable or wirelessly. When image formation apparatus **10** receives, from the host computer or the external apparatus, print data and an instruction to make the printing using print media **100** stored in medium feeder F of the main body of image formation apparatus **10**, image formation apparatus **10** makes sheet-feeder motor **91** rotate pick-up roller **12-1** and sheet-feeder roller **13-1**. With the rotation of pick-up roller **12-1**, each of print media **100** is separated from the others. Then, print media **100** thus separated are sent one by one to the downstream side of the medium conveyance path.

Print medium **100** sent from pick-up roller **12-1** is further conveyed by sheet-feeder roller **13-1**. Note that the driving of resist motor **93**, belt motor **95**, drum motor **94**, and fixation motor **96** is started substantially at the same time as the driving of sheet-feeder motor **91**.

Print medium **100** that has been conveyed by the drive force of sheet-feeder motor **91** is then conveyed substantially at the same speed by first resist-roller pair **16-1** and then by second resist-roller pair **18**. To this end, resist motor **93** is rotated substantially at the same speed beforehand.

In addition, the image formation process is started by the charging operation to electrically charge the surface of photosensitive drum **23** as the image carrier at a certain potential or even higher. Hence, photosensitive drums **23** and conveyor belt **31** are made to rotate at the same speed by drum motor **94** and belt motor **95**, respectively.

Note that, if the temperature of fixation roller **41** is at a target temperature, the driving of fixation motor **96** is started substantially at the same time as the feeding of print medium **100** is started as described earlier. If, conversely, the temperature of fixation roller **41** is lower than the target temperature, the driving of fixation motor **96** is started before the feeding of print medium **100** is started to warm up fixation roller **41**.

Once sheet-feed sensor **14-1** detects that print medium **100** is fed properly, butting control to correct skew of print medium **100** is performed by using first IN-sensor **15-1** and first resist-roller pair **16-1**. While skew is corrected, the drive force of resist motor **93** is cut off by an unillustrated drive-force transmission device. When the butting action of a predetermined amount is completed, the drive-force transmission device is switched to a transmission state, and thus the conveyance of print medium **100** is resumed.

Print medium **100** passes through second IN-sensor **17**, and then is conveyed to second resist-roller pair **18**. Print medium **100** is then conveyed by second resist-roller pair **18** to pass through WR sensor **19**, and then gets on top of conveyor belt **31** to be conveyed by conveyor belt **31**.

To be more specific, print medium **100** turns ON WR sensor **19**, and then is conveyed to conveyor belt **31** located downstream in the medium conveyance path. A certain time after WR sensor **19** is turned ON, LED heads **25** of image formation units **22** of black (K), yellow (Y), magenta (M), and cyan (C) start radiating light to form electrostatic latent images of their respective colors on their respective photosensitive drums **23**.

Belt drive roller **33** rotates to drive the conveyor belt **31** wound across belt drive roller **33** and the driven roller **32** to rotate along the medium conveyance path. Print medium **100** is conveyed by the driving of conveyor belt **31** sequentially to the four image formation units **22** (=**22-1** to **22-4**) arranged in the order of black (K), yellow (Y), magenta (M), and cyan (C).

Photosensitive drum **23** of each of the four image formation units **22** of black (K), yellow (Y), magenta (M), and cyan (C) rotates anticlockwise, and the surface of each photosensitive drum **23** is uniformly charged by the corresponding charger roller **24**. Each uniformly charged photosensitive drum **23** is then irradiated with light based on the image data received from the host computer or the external apparatus radiated by LED head **25**. Thus, an electrostatic latent image is formed on photosensitive drum **23**. Photosensitive drum **23** with the electrostatic latent image formed on the surface is then subjected to a development of the toner image performed by supply roller **27** and development roller **26**. Image transfer roller **21** and photosensitive drum **23** sandwich (nip) therebetween print medium **100** and conveyor belt **31** and convey print medium **100**. A voltage of approximately +3000 V that is applied to each image transfer roller **21** attracts, to print medium **100**, the toner on the surface of photosensitive drum **23**. Thereby each toner image is transferred to the surface of print medium **100**. Print medium **100** with the transferred toner images is then sent to fixation unit **40**. The toner remaining on photosensitive drum is scraped off by cleaning blade **28**, and thus photosensitive drum **23** is made ready for the formation of another toner image.

The image formation process includes: a step of electrically charging the surface of photosensitive drum **23** by charger roller **24**; irradiating the surface of photosensitive drum **23** with light radiated by LED head **25** to form an electrostatic latent image on the surface of photosensitive drum **23**; developing the electrostatic latent image formed on the surface of photosensitive drum **23** as the image carrier by development roller **26** to form a toner image on the surface of photosensitive drum **23**; and transferring the toner image formed on the surface of photosensitive drum **23** to the surface of print medium **100** by image transfer roller **21**.

After toner images of the four colors of black (K), yellow (Y), magenta (M), and cyan (C) are transferred to the surface of print medium **100**, print medium **100** is conveyed to fixation unit **40**. In fixation unit **40**, print medium **100** is nipped by and conveyed through nip portion formed by fixation roller **41** and back-up roller **42**. In the nip portion, the heat from fixation roller **41** and the pressure caused by the biasing force of back-up roller **42** are applied to print medium **100**. Thus, the toner is melted and the toner images are fixed to the surface of print medium **100**.

After the toner images are fixed to the surface of print medium **100**, the leading end of print medium **100** is detected by EXIT sensor **51**. Then, print medium **100** is conveyed by the rotations of pairs of discharger rollers **52** to **54**. A predetermined time after print medium **100** passes through EXIT sensor **51**, belt motor **95** and drum motor **94** are stopped. A predetermined time after that, fixation motor **96** is stopped. Print medium **100** thus conveyed is then discharged to stacker **55** or face-up stacker **56** through a discharge route selected by the user.

(Operations of Comparative Example: Case of Using First Optional Tray **11-3**)

By referring to FIG. **1**, description is given of the operations of the comparative example of a different case where print medium **100** is fed from first optional tray **11-3** of image formation apparatus **10**.

Firstly, image formation apparatus **10** receives, from an external apparatus or a host computer (not illustrated), print data and an instruction to perform the printing using print media **100** stored in first optional tray **11-3**. Then, image formation apparatus **10** makes first-optional-tray motor **92-3** rotate pick-up roller **12-3** and sheet-feeder roller **13-3**. With the rotations of pick-up roller **12-3**, each of print media **100** is separated from the others. Then, the print media **100** thus separated are sent, one by one, to the downstream side of the medium conveyance path.

After print medium **100** passes through pick-up roller **12-3**, sheet-feeder roller **13-3** further conveys print medium **100**. Note that the driving of resist motor **93**, belt motor **95**, drum motor **94**, fixation motor **96**, and second-optional-tray motor **92-2** is started substantially at the same time as the driving of first-optional-tray motor **92-3** is started.

The image formation process is started by the start of the charging operation to electrically charge the surface of photosensitive drums **23** at a certain potential or higher.

Note that, if the temperature of fixation roller **41** is at a target temperature, the driving of fixation motor **96** is started substantially at the same time as the feeding of print medium **100** is started as described earlier. If, conversely, the temperature of fixation roller **41** is lower than the target temperature, the driving of fixation motor **96** is started before the feeding of print medium **100** is started to warm up fixation roller **41**.

When sheet-feed sensor **14-3** detects that print medium **100** is fed properly, butting control to correct skew of print medium **100** is performed by using conveyance sensor **15-3** and conveyance rollers **16-3**. Print medium **100** passes through conveyance sensor **15-2** as a medium detector, conveyance rollers **16-2**, first IN-sensor **15-1**, first resist-roller pair **16-1**, and second IN-sensor **17** to be conveyed to second resist-roller pair **18**. After print medium **100** is conveyed to second resist-roller pair **18**, print medium **100** passes through WR sensor **19**, and then gets on top of conveyor belt **31** to be further conveyed by conveyor belt **31**.

The operations performed thereafter are the same as those performed in the case where print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10**. Print medium **100** turns ON WR sensor **19**, and then is conveyed to conveyor belt **31** located downstream of WR sensor **19** in the medium conveyance path. Then, print medium **100** is conveyed sequentially to the four image formation units **22** of black (K), yellow (Y), magenta (M), and cyan (C) arranged in this order.

Toner images of the four colors are conveyed to print medium **100** by the four image formation units **22**, and then the toner images are fixed by fixation unit **40**.

After the toner images are fixed to the surface of print medium **100**, the leading end of print medium **100** is detected by EXIT sensor **51**, and print medium **100** is conveyed by the rotations of pairs of discharger rollers **52** to **54**. A predetermined time after print medium **100** passes through EXIT sensor **51**, belt motor **95** and drum motor **94** are stopped. A predetermined time after that, fixation motor **96** is stopped. Print medium **100** thus conveyed is then discharged to stacker **55** or face-up stacker **56** through a discharge route selected by the user.

(Operations of First Embodiment)

A feature of the first embodiment lies in the control method of a case where print medium **100** is conveyed over a long distance. So, the following description is given of the operations of a case where print medium **100** is fed from first optional tray **11-3**. Note that the operations of the first embodiment is also applicable to a case where print medium **100** is fed from second optional tray **11-2**. If print medium **100** fed from medium feeder F has to be conveyed over a long distance, the operations of the first embodiment is also applicable to a case where print medium **100** is fed from medium feeder F.

Image formation apparatus **10** receives, from an unillustrated external apparatus, print data and an instruction to perform the printing using print media **100** stored in first optional tray **11-3**. Then, image formation apparatus **10** makes first-optional-tray motor **92-3** rotate pick-up roller **12-3** and sheet-feeder roller **13-3**. With the rotation of pick-up roller **12-3**, each of print media **100** is separated from the others. Then, the print media **100** thus separated are sent, one by one, to the downstream side of the medium conveyance path.

In this first embodiment, on the basis of the print data sent from the host computer or the external apparatus, image processor circuit **61** as a size detector detects the conveyance-direction dimension of print medium **100**.

After print medium **100** passes through pick-up roller **12-3**, sheet-feeder roller **13-3** further conveys print medium **100**. Note that in this first embodiment, the driving of resist motor **93**, fixation motor **96**, and second-optional-tray motor **92-2** is started substantially at the same time as the driving of first-optional-tray motor **92-3**. Unlike the comparative example, the driving of neither belt motor **95** nor drum motor **94** is started at that timing.

The rotations of neither belt motor **95** nor drum motor **94** of this first embodiment are started substantially at the same time as the rotations of first-optional-tray motor **92-3** are started because first optional tray **11-3** is provided at the upstream side, in the medium-conveyance direction, of point P as the most downstream position for print medium **100** within the zone that allows the toner-image transfer at image transfer position B to be performed in time. Thus, the distance from this first optional tray **11-3** to image transfer position B is long. Accordingly, at the time when the feeding of print medium **100** from first optional tray **11-3** is started, the position of print medium **100** while being conveyed in the medium-conveyance path is still within a zone that allows the toner-image transfer at image transfer position B to be performed in time. The above-mentioned zone that allows the toner-image transfer at image transfer position B to be performed in time refers to a position that satisfies the following condition. The distance measured along the medium-conveyance path from each of the positions to image transfer position B of the most upstream image formation unit **22-1** is not shorter than the distance by which photosensitive drum **23** rotates for a period starting from the beginning of the image formation process to form a toner image on the surface of photosensitive drums **23-1** and ending with the transferring of the toner image thus formed onto the surface of print medium **100** at image transfer position B.

Note that, if the temperature of fixation roller **41** is at the target temperature, the driving of fixation motor **96** is started substantially at the same time as the feeding of print medium **100** is started as described earlier. If, conversely, the temperature of fixation roller **41** is lower than the target temperature, the driving of fixation motor **96** is started before the feeding of print medium **100** is started to warm up fixation roller **41**.

When sheet-feed sensor **14-3** detects that print medium **100** is fed properly, butting control to correct skew of print medium **100** is performed by using conveyance sensor **15-3** and conveyance rollers **16-3**. Print medium **100** passes through conveyance sensor **15-2**, conveyance rollers **16-2**, first IN-sensor **15-1**, first resist-roller pair **16-1**, and second IN-sensor **17**. Then, print medium **100** is conveyed to second resist-roller pair **18**.

In this first embodiment, when conveyance sensor **15-2** detects the leading end of print medium **100**, controller **60** makes optional tray controller **80** of second optional tray **11-2** count the number of drive pulses outputted from the detection position through I/O port **85** to driver circuits **86-2** of second-optional-tray motor **92-2**. With this counting, the driving of drum motor **94** and belt motor **95** is started at the time when the distance from the leading end of print medium **100** to the position of nip portion B (i.e., image transfer position) between photosensitive drum **23-1** and image transfer roller **21-1** becomes substantially equal to the distance L**1** from medium feeder F of the main body of image formation apparatus **10** to the position of nip portion B (at the time when the leading end of print medium **100** arrives at the most downstream position P within the above-described zone that allows the toner-image transfer to be performed in time).

In this first embodiment, the delayed start of the rotations of belt motor **95** and drum motor **94** reduces the number of rotations of photosensitive drum **23** and conveyor belt **31** rotating wastefully in the above-described comparative example. Hence, the wear of photosensitive drum **23** and conveyor belt **31** caused by their rotations can be reduced. In addition, even if print medium **100** is fed from optional tray **11-3**, the rotations of conveyor belt **31** and photosensitive drum **23** is started at the same timing as in the case where print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10**. Hence, the surface of photosensitive drum **23** can be electrically charged reliably. As a consequence, the degradation of image quality due to charging failure can be avoided.

After that, print medium **100** is conveyed by second resist-roller pair **18**, and then passes through WR sensor **19**. Then print medium **100** gets on top of conveyor belt **31** to be conveyed further by conveyor belt **31**.

Print medium **100** turns ON WR sensor **19**, and then is conveyed to conveyor belt **31** that is located downstream in the medium conveyance path. Then, print medium **100** is conveyed sequentially to the four image formation units **22** of black (K), yellow (Y), magenta (M), and cyan (C) arranged in this order

Toner images of the four colors are transferred to print medium **100** by the image formation units **22**, and then the toner images are fixed to the surface of print medium **100** by fixation unit **40**.

After the toner images are fixed to the surface of print medium **100**, the leading end of print medium **100** is detected by EXIT sensor **51**, and print medium **100** is conveyed by the rotations of pairs of discharger rollers **52** to **54**. Note that in this first embodiment, image processor circuit **61** as a medium-size detector detects the conveyance-direction dimension of print medium **100** on the basis of the print data sent from a host computer or an external apparatus. Hence, the rotations of conveyor belt **31** and photosensitive drum **23** can be stopped before the trailing end of print medium **100** completely passes through fixation roller **41** and then through EXIT sensor **51**. Specifically, the number of drive pulses of belt motor **95** after the detection of the leading end of print medium **100** by EXIT sensor **51** is measured, and then whether or not the trailing end of print medium **100** has passed through the image transfer position of the most downstream image formation unit **22-4** is judged on the basis of the measured number of drive pulses. Then, belt motor **95** and drum motor **94** are stopped. The judgment relies on a threshold value of the number of drive pulses. The threshold value of the number of drive pulses is the number of drive pulses of a case where the print medium **100** is conveyed over a distance obtained by subtracting the first distance between the most downstream image formation unit **22-4** and EXIT sensor **51** from conveyance-direction dimension of print medium **100**.

A predetermined time after that, fixation motor **96** is stopped. Print medium **100** thus conveyed is then discharged to stacker **55** or face-up stacker **56** through a discharge route selected by the user.

FIG. **5** is a flowchart illustrating the operations of image formation apparatus **10** according to the first embodiment of the invention. FIG. **6** is a time chart illustrating the operations of image formation apparatus **10** according to the first embodiment of the invention.

In the time chart of FIG. **6**, the vertical axis represents an ON state at the upper position and an OFF state at the lower position. The horizontal axis represents the passage of time. The thick solid lines are of the control performed in the first embodiment while the thick dashed lines represent the control performed in the comparative example.

At the beginning of the process, at step S**1**, controller **60** of image formation apparatus **10** turns ON first-optional-tray motor **92-3**, second-optional-tray motor **92-2**, resist motor **93**, fixation motor **96**, and high-voltage power supply **63** not illustrated in the time chart but needed for the electrophotographic process.

At step S**2**, controller **60** of image formation apparatus **10** waits for the leading end of print medium **100** fed from first optional tray **11-3** to turn ON conveyance sensor **15-2** of second optional tray **11-2**.

At step S**3**, controller **60** of image formation apparatus **10** instructs optional tray controller **80** to continue the conveyance of print medium **100** until it is judged that the conveyance of print medium **100** over distance D**1** is completed. Distance D**1** is obtained by adding a safety margin to the distance over which print medium **100** is conveyed since the leading end of print medium **100** turns ON conveyance sensor **15-2** of second optional tray **11-2** until the trailing end of print medium **100** passes through conveyance rollers **16-3** of first optional tray **11-3**.

At step S**4**, controller **60** of image formation apparatus **10** instructs optional tray controller **80** to stop first-optional-tray motor **92-3**. In addition, controller **60** starts driving belt motor **95** and drum motor **94**, and turns ON high-voltage power supply **63**. From then onwards, print medium **100** is conveyed without being driven by first-optional-tray motor **92-3** (pick-up roller **12-3** and sheet-feeder roller **13-3**).

Upon detecting the turning ON of second IN-sensor **17** at step S**5**, controller **60** of image formation apparatus **10** waits for print medium **100** to be conveyed over distance D**2** after turning ON second IN-sensor **17** at step S**6**. Distance D**2** is obtained by adding a safety margin to the distance over which print medium **100** is conveyed after the leading end of print medium **100** turns ON second IN-sensor **17** until the trailing end of print medium **100** passes by conveyance rollers **16-2** of second optional tray **11-2**.

If controller **60** judges that print medium **100** is conveyed over distance D**2** after turning ON of second IN-sensor **17** (Yes at step S**6**), then at step S**7** controller **60** of image formation apparatus **10** instructs optional tray controller **80** to turn OFF second-optional-tray motor **92-2** thereby stopping the rotation of conveyance rollers **16-2**. Accordingly, from then onwards, print medium **100** is conveyed without being driven by second-optional-tray motor **92-2** (conveyance rollers **16-2**).

Upon detecting the turning OFF of WR sensor **19** by the trailing end of print medium **100** at step S**8**, controller **60** of image formation apparatus **10** waits for print medium **100** to be conveyed over distance D**3** at step S**9**. Distance D**3** is the safety margin after the trailing end of print medium **100** passes by WR sensor **19**.

If controller **60** of image formation apparatus **10** judges that print medium **100** is conveyed over distance D**3** after turning OFF WR sensor **19** (Yes at step S**9**), at step S**10**, controller **60** turns OFF resist motor **93** to stop the rotations of first resist-roller pair **16-1** and second resist-roller pair **18**. Hence, print medium **100** is conveyed toward the downstream by the conveyance force of photosensitive drum **23** and image transfer roller **21** and by the conveyance force of fixation unit **40**.

Upon detecting the turning ON of EXIT sensor **51** by the leading end of print medium **100**, at step S**11**, controller **60** of image formation apparatus **10** waits for print medium **100** to be conveyed over distance D**4** at step S**12**. Distance D**4** is obtained by adding a safety margin to the distance over which print medium **100** is conveyed after the trailing end of print medium **100** passes through EXIT sensor **51** until the leading end of print medium **100** passes through the most downstream image formation unit **22-4**.

If controller **60** of image formation apparatus **10** judges that print medium **100** is conveyed over distance D**4** after turning ON of EXIT sensor **51** (Yes at step S**12**), then at step S**13**, controller **60** stops drum motor **94** and belt motor **95** and turns OFF high-voltage power supply **63**.

If, at step S**14**, controller **60** of image formation apparatus **10** judges that the discharge of print medium **100** by fixation motor **96** has been completed and that the temperature of fixation unit **40** is low enough to stop the rotation, then at step S**15**, controller **60** stops fixation motor **96**, thereby terminates the print operations shown in FIG. **5**.

(Effects of First Embodiment)

Image formation apparatus **10** of this first embodiment has the following effects (A) to (C).

(A) In the comparative example, even if image formation process is started while print medium **100** is within the zone that allows the transferring of the toner image to be performed in time (i.e., even if print medium **100** is at the upstream side of the most downstream position P of the above-mentioned zone for in-time toner-image transfer), photosensitive drum **23** and conveyor belt **31** rotate wastefully. In contrast, in this first embodiment, the driving of drum motor **94** and belt motor **95** is started at the time when print medium **100** arrives at the most downstream position P of the zone that allows the toner-image transfer to be performed in time. Accordingly, photosensitive drum **23** and conveyor belt are prevented from rotating wastefully, and the service lives of these consumable members can be prolonged.

(B) In this first embodiment, belt motor **95** and drum motor **94** are stopped if it is judged that the trailing end of print medium **100** passes through the image transfer position of the most downstream image formation unit **22-4**. Accordingly, photosensitive drum **23** and conveyor belt **31** are prevented from rotating wastefully, and the service lives of these consumable members can be prolonged.

(C) Controller **60** controls the driving of photosensitive drum **23** and image transfer roller **21** on the basis of the detection results of conveyance sensor **15-2** provided at a substantially linear section of the medium conveyance path which allows print medium **100** to be conveyed stably and located at the upstream side, in the medium-conveyance direction, of photosensitive drum **23-1** and downstream, in the medium-conveyance direction, of first optional tray **11-3**. Accordingly, even if print medium **100** is fed from first optional tray **11-3** not smoothly, the driving of photosensitive drum **23** and image transfer roller **21** can be controlled stably.

Second Embodiment

Configuration of Second Embodiment

In a second embodiment of the invention, image formation apparatus **10** has an identical configuration to the one in the first embodiment shown in FIG. **1**, but has different operations.

In the second embodiment, if it is judged that photosensitive drums **23** has a surface potential that is equal to or higher than a predetermined threshold, the charging step performed at the beginning of the above-described image formation process in the first embodiment is omitted. As a consequence, the start of the image formation process is delayed further.

FIG. **7** is a chart illustrating the relationship between the surface potential of photosensitive drum **23** shown in FIG. **2** and the elapsed time. The vertical axis represents the surface potential of photosensitive drum **23** whereas the horizontal axis represents the elapsed time.

The graph shown in FIG. **7** illustrates how the surface potential of photosensitive drum **23** attenuates as time elapses since the application of voltage to photosensitive drum **23** is stopped. Threshold voltage Vx is the limit value of the surface potential that does not adversely affect the image quality. Threshold time Tx is the elapsed time until the surface potential is lowered down to threshold voltage Vx.

The data on the attenuation characteristics of the surface potential of photosensitive drum **23** shown in FIG. **7** are stored in non-volatile memory **67**. Note that photosensitive drum **23** of this second embodiment preferably has favorable surface-potential attenuation characteristics so that the surface potential of photosensitive drum **23** attenuate slowly.

(Operations of Second Embodiment)

Operations of this second embodiment are described by referring to FIG. **1**.

As in the first embodiment, a feature of the second embodiment lies in the control method of a case where print medium **100** is conveyed over a long distance. So, the following description is given of the operations of a case where print medium **100** is fed from first optional tray **11-3**. Note that the operations of the second embodiment is also applicable to a case where print medium **100** is fed from second optional tray **11-2**. If print medium **100** fed from medium feeder F of the main body of image formation apparatus **10** has to be conveyed over a long distance, the operations of the second embodiment is also applicable to a case where print medium **100** is fed from medium feeder F.

Image formation apparatus **10** receives, from an unillustrated external apparatus, print data and an instruction to make the printing be performed using print media **100** stored in first optional tray **11-3**. Then, image formation apparatus **10** makes first-optional-tray motor **92-3** rotate pick-up roller **12-3** and sheet-feeder roller **13-3**. With the rotations of pick-up roller **12-3**, each of print media **100** is separated from the others. Then, the print media **100** thus separated are sent, one by one, to the downstream side of the medium conveyance path.

As in the first embodiment, in this second embodiment, on the basis of the print data sent from the host computer or the external apparatus, image processor circuit **61** as a size detector detects the conveyance-direction dimension of print medium **100**.

After print medium **100** passes through pick-up roller **12-3**, sheet-feeder roller **13-3** further conveys print medium **100**. Note that, as in the first embodiment, in this second embodiment, the driving of resist motor **93**, fixation motor **96**, and second-optional-tray motor **92-2** is started substantially at the same time as the driving of first-optional-tray motor **92-3** is started. Unlike the comparative example, the driving of neither belt motor **95** nor drum motor **94** is started at that timing. In this second embodiment, the rotations of neither belt motor **95** nor drum motor **94** are started substantially at the same time as the rotations of first-optional-tray motor **92-3** are started. This is because of a similar reason to the one in the first embodiment.

Note that, if the temperature of fixation roller **41** is at the target temperature, the driving of fixation motor **96** is started substantially at the same time as the feeding of print medium **100** is started as described earlier. If, conversely, the temperature of fixation roller **41** is lower than the target temperature, the driving of fixation motor **96** is started before the feeding of print medium **100** is started to warm up fixation roller **41**.

When sheet-feed sensor **14-3** detects that print medium **100** is fed properly, butting control to correct skew of print medium **100** is performed by using conveyance sensor **15-3** and conveyance rollers **16-3**. Print medium **100** passes through conveyance sensor **15-2**, conveyance rollers **16-2**, first IN-sensor **15-1**, first resist-roller pair **16-1**, and second IN-sensor **17**. Then, print medium **100** is conveyed to second resist-roller pair **18**.

As in the first embodiment, in this second embodiment, when conveyance sensor **15-2** detects the leading end of print medium **100**, controller **60** makes optional tray controller **80** of second optional tray **11-2** count the number of drive pulses outputted from the detection position through I/O port **85** to driver circuits **86-2** of second-optional-tray motor **92-2**. On the basis of this counting, controller **60** of this second embodiment judges whether or not the distance from the leading end of print medium **100** to the position of nip portion B (image transfer position) between photosensitive drum **23-1** and image transfer roller **21-1** is equal to distance L**1** from medium feeder F to the position of nip portion B. If controller **60** judges that the above-mentioned two distances are substantially equal to each other, controller **60** then judges whether or not the charging-process suspension period measured by timer **78** as a charge-voltage judgment portion exceeds threshold time Tx shown in FIG. **7**. Note that the charging-process suspension period is the time elapsed since the application of voltage to photosensitive drum **23** is stopped.

If controller **60** judges that the charging-process suspension period exceeds the threshold time Tx (i.e., that the image quality deteriorates when no extra charging process is performed), the driving of drum motor **94** and belt motor **95** is started, and high-voltage power supply **63** is turned ON, as in the case of the first embodiment.

If, in contrast, controller **60** judges that the charging-process suspension period does not exceed the threshold time Tx, that is, that the surface potential of photosensitive drum **23** is high enough to allow image formation process to be performed without an extra charging process, controller **60** turns OFF only first-optional-tray motor **92-3**. Then, if controller **60** judges that print medium **100** has been conveyed over distance D**5** after the detection of the turning ON of WR sensor **19**, controller **60** starts driving drum motor **94** and belt motor **95** and turns ON high-voltage power supply **63**. Distance D**5** is the distance from the position where the leading end of print medium **100** reaches WR sensor **19** to a predetermined position that guarantees the in-time arrival of print medium **100** for image formation process. Note that, unlike the image formation process of the first embodiment, the image formation process of this second embodiment is not commenced by the start of the charging process but by the start of latent-image formation process to form an electrostatic latent image on the surface of photosensitive drum **23** as an image carrier.

In this second embodiment, controller **60** measures the length of time the charging process to electrically charge the surface of each photosensitive drum **23** is suspended. If the result of measurement does not reach threshold time Tx, controller **60** judges that the image quality is not adversely affected even when no extra charging process is performed. Hence, controller **60** begins the image formation process with the start of rotation of photosensitive drum **23** to start light exposure and with the start of the rotations of the conveyor belt **31** without performing any preceding charging process. The start of the driving of belt motor **95** and drum motor **94** at this time delays the start of rotations of photosensitive drums **32** and conveyor belt **31** in comparison to the cases of the control in the comparative example or of the control in the first embodiment. Accordingly, the numbers of rotations of photosensitive drum **23** and conveyor belt **31** are reduced from their respective counterparts in the case of the control of the comparative example or in the case of the control of the first embodiment. Consequently, the wear of these members can be reduced more effectively.

After that, print medium **100** is conveyed to second resist-roller pair **18**, and then passes through WR sensor **19**. Then print medium **100** gets on top of conveyor belt **31** to be conveyed further by conveyor belt **31**.

Print medium **100** turns ON WR sensor **19**, and then is conveyed to conveyor belt **31** that is located downstream in the medium conveyance path. Then, print medium **100** is conveyed sequentially to the four image formation units **22** of black (K), yellow (Y), magenta (M), and cyan, arranged in this order. Toner images of the four colors are transferred to print medium **100** by the image formation units **22**, and then the toner images are fixed to the surface of print medium **100** by fixation unit **40**.

After the toner images are fixed to the surface of print medium **100**, the leading end of print medium **100** is detected by EXIT sensor **51**, and then print medium **100** is conveyed by the rotations of pairs of discharger rollers **52** to **54**. Note that, as in the first embodiment, in this second embodiment, image processor circuit **61** as a medium-size detector detects the conveyance-direction dimension of print medium **100** on the basis of the print data sent from a host computer or an external apparatus. Hence, the rotations of conveyor belt **31** and photosensitive drum **23** can be stopped before the trailing end of print medium **100** completely passes through fixation roller **41** and then through EXIT sensor **51**. Specifically, the number of drive pulses of belt motor **95** after the detection of the leading end of print medium **100** by EXIT sensor **51** is measured, and then if it judged that the trailing end of print medium **100** has passed through the image transfer position of the most downstream image formation unit **22-4** on the basis of the measured number of drive pulses, belt motor **95** and drum motor **94** are stopped. A predetermined time after that, fixation motor **96** is stopped.

Print medium **100** thus conveyed is then discharged to stacker **55** or face-up stacker **56** through a discharge route selected by the user.

FIGS. **8** and **9** are flowcharts (Part 1 and Part 2) illustrating the operations of the image formation apparatus according to the second embodiment of the invention. Elements therein that are the same as the ones that appear in FIG. **5** showing the first embodiment are denoted by their respective reference numerals.

FIG. **10** is a time chart illustrating the operations of the image formation apparatus of the second embodiment of the invention of a case where the charging-process suspension period does not exceed threshold time Tx. Elements in FIG. **10** same as the ones those in FIG. **6** showing the first embodiment are denoted by their respective reference numerals. In the time chart of FIG. **10**, the vertical axis represents an ON state at the upper position and an OFF state at the lower position. The horizontal axis represents the passage of time. The thick solid lines are of the control performed in the second embodiment while the thick dashed lines represent the control performed in the comparative example.

At the beginning of the processes, the processes performed at steps S1 to S3 are the same as those the first embodiment. At step S**20**, controller **60** of image formation apparatus **10** judges whether or not the charging-process suspension period measured by timer **78** exceeds threshold time Tx shown in FIG. **7**.

If charging-process suspension period does not exceed threshold time Tx, first-optional-tray motor **92-3** is turned OFF, and the rotations of pick-up roller **12-3** and sheet-feeder roller **13-3** are stopped at step S**4**A. From then onwards, print medium **100** is conveyed without being driven by first-optional-tray motor **92-3** (pick-up roller **12-3** and sheet-feeder roller **13-3**). The processes at steps S**5**A to S**7**A are similar to the processes at steps S**5** to S**7** in the first embodiment. If, at step S**21**A, the turning ON of WR sensor **19** is detected, controller **60** of image formation apparatus **10** waits for print medium **100** to be conveyed over distance D**5** at step S**22**. Distance D**5** is the distance from the position where the leading end of print medium **100** reaches WR sensor **19** to a predetermined position that guarantees the in-time arrival of print medium **100** for image formation process. If, at step S**22**, controller **60** of image formation apparatus **10** judges that print medium **100** has been conveyed over distance D**5** after turning ON of WR sensor **19**, then at step S**23**, controller **60** starts driving drum motor **94** and belt motor **95** and turns ON high-voltage power supply **63**.

If, in contrast, at step S**20**, the charging-process suspension period exceeds threshold time Tx, the processes at step S**4** to S**7** are performed, and then at step S**21** controller **60** waits for the turning ON of WR sensor **19** to be detected. Then at step S**8**, the process that is similar to that at step S**8** in the first embodiment is performed. After that, the processes of node A shown in FIG. **9** are performed.

Once the processes of node A shown in FIG. **9** are started, the processes of step S**9** to S**15** are performed as in the first embodiment. Then, the print process shown in FIG. **9** is terminated.

(Effects of Second Embodiment)

Image formation apparatus **10** of this second embodiment can delay further the start of the driving of photosensitive drum **23** and conveyor belt **31**. Hence, the period in which the driving of photosensitive drum **23** and conveyor belt **31** can be suspended can be prolonged. Accordingly, the idle driving of photosensitive drum **23** and conveyor belt **31** can be reduced even from the case of the first embodiment. As a consequence, the service lives of these members can be prolonged even further.

## Third Embodiment

### Configuration of Third Embodiment

The configuration of image formation apparatus **10** of a third embodiment of the invention is identical to the configuration of image formation apparatus **10** of the first embodiment shown in FIG. **1**.

(Operations of Third Embodiment)

A feature of the third embodiment lies in the control method of a case where print medium **100** is conveyed over a long distance. So, the following description is given of the operations of a case where print medium **100** is fed from first optional tray **11-3**. If the conveyed distance is long, the operations of the third embodiment is also applicable to a case where print medium **100** is fed from second optional tray **11-2** and to a case where print medium **100** is fed from medium feeder F.

Image formation apparatus **10** receives, from an unillustrated external apparatus, print data and an instruction to make the printing be performed using print media **100** stored in first optional tray **11-3**. Then, image formation apparatus **10** makes first-optional-tray motor **92-3** rotate pick-up roller **12-3** and sheet-feeder roller **13-3**. With the rotations of pick-up roller **12-3**, each of print media **100** is separated from the others. Then, the print media **100** thus separated are sent, one by one, to the downstream side of the medium conveyance path.

As in the first and the second embodiments, in this third embodiment, on the basis of the print data sent from the host computer or the external apparatus, image processor circuit **61** as the size detector detects the conveyance-direction dimension of print medium **100**.

After print medium **100** passes through pick-up roller **12-3**, sheet-feeder roller **13-3** further conveys print medium **100**. In this third embodiment, the driving of resist motor **93**, fixation motor **96**, second-optional-tray motor **92-2**, belt motor **95**, and drum motor **94** is started, and high-voltage power supply **63** is turned ON substantially at the same time as the driving of the first-optional-tray motor **92-3** is started. In this case, the drive speed (first speed) of belt motor **95** and drum motor **94** are slower at the beginning of the drive than the drive speed (second speed) of these motors **95** and **94** at the time of the toner-image transfer. The drive speed of these motors **95** and **94** is switched from the first speed to the second speed at a time when the leading end of print medium **100** reaches point P in the medium conveyance path. Accordingly, in comparison to a case where photosensitive drum **23** and conveyor belt **31** always rotate at the normal rotational speeds (moving speeds), the wear of photosensitive drum **23** and conveyor belt **31** can be reduced, and the service lives of photosensitive drum **23** and conveyor belt **31** can be prolonged.

Note that if the temperature of fixation roller **41** is at the target temperature, the driving of fixation motor **96** is started substantially at the same time as the feeding of print medium **100** is started as described earlier. If, in contrast, the temperature of fixation roller **41** is lower than the target temperature, the driving of fixation motor **96** precedes the start of the feeding of print medium **10** to warm up fixation roller **41**.

When sheet-feed sensor **14-3** detects that print medium **100** is fed properly, butting control to correct skew of print medium **100** is performed using conveyance sensor **15-3** and conveyance rollers **16-3**. Print medium **100** passes by conveyance sensor **15-2**, conveyance rollers **16-2**, first IN-sensor **15-1**, first resist-roller pair **16-1**, and second IN-sensor **17**, and then is conveyed to second resist-roller pair **18**.

As in the first and the second embodiments, if, in this third embodiment, the conveyance sensor **15-2** detects the leading end of print medium **100**, the counting of the number of drive pulses of driver circuit **86-2** of second-optional-tray motor **92-2** is started by using optional tray controller **80** of second optional tray **11-2**. Specifically, the counting starts at the time when the print medium **100** is at this detection position. On the basis of this counting, the drive speed of the drum motor **94** and that of belt motor **95** is switched to the drive speed (the second speed) at the time of toner-image transfer. Specifically, the switching of the speeds is done at a time when it is judged that the conveyance distance of the print medium **100** measured from the position of the leading end of print medium **100** to the position of nip portion B (image transfer position) becomes substantially equal to the conveyance distance (L**1**) measured from medium feeder F of main body of image formation apparatus **10** to the position of nip portion B. To put it differently, the speed is switched at the time when it is judged that the leading end of print medium **100** reaches point P.

In this third embodiment, the drive speed of belt motor **95** and drum motor **94** is switched from the slow first speed to the normal second speed at the above-described timing. Accordingly, the number of rotations of photosensitive drum **23** and that of conveyor belt **31** before switching of the speed can be reduced. Consequently, the wear of photosensitive drum **23** and conveyor belt **31** can be reduced. In addition, in this third embodiment, the rotational speed of belt motor **95** and drum motor **94** is slowed down before this timing, but the surface of photosensitive drum **23** is electrically charged reliably by high-voltage power supply **63**. Consequently, the deterioration of image quality due to charging failure can be avoided.

Print medium **100** is then conveyed by second resist-roller pair **18** to passes through WR sensor **19**, and then gets on top of conveyor belt **31** to be conveyed by conveyor belt **31**.

To be more specific, print medium **100** turns ON WR sensor **19**, and then is conveyed by conveyor belt **31** located downstream in the medium conveyance path sequentially to the four image formation units **22** of black (K), yellow (Y), magenta (M), and cyan (C) arranged in the order of black.

Toner images of the four colors are transferred to the surface of print medium **100** by image formation units **22**, and then the toner images are fixed to the surface of print medium **100** by fixation unit **40**.

After the toner images are fixed to the surface of print medium **100**, the leading end of print medium **100** is detected by EXIT sensor **51**, and then print medium **100** is conveyed by the rotations of pairs of discharger rollers **52** to **54**. Note that, as in the first and the second embodiments, in this third embodiment, image processor circuit **61** as the medium-size detector detects the conveyance-direction dimension of print medium **100** on the basis of the print data sent from a host computer or an external apparatus. Hence, the rotations of conveyor belt **31** and photosensitive drum **23** can be stopped before the trailing end of print medium **100** completely passes through fixation roller **41** and then through EXIT sensor **51**. Specifically, the number of drive pulses of belt motor **95** after the detection of the leading end of print medium **100** by EXIT sensor **51** is measured, and then if it is judged that the trailing end of print medium **100** has passed through the image transfer position of the most downstream image formation unit **22-4** on the basis of the measured number of drive pulses, controller **60** stops belt motor **95** and drum motor **94**. A predetermined time after that, controller **60** stops fixation motor **96**.

Print medium **100** thus conveyed is then discharged to stacker **55** or face-up stacker **56** through a discharge route selected by the user.

FIG. **11** is a flowchart illustrating the operations of the image formation apparatus according to the third embodiment of the invention. Elements therein that are the same as the ones that appear in FIG. **5** showing the first embodiment are denoted by their respective reference numerals.

FIG. **12** is a time chart illustrating the operations of the image formation apparatus of the third embodiment of the invention of a case where the charging-process suspension period does not exceed threshold time Tx. Elements in FIG. **12** same as the ones those in FIG. **6** showing the first embodiment are denoted by their respective reference numerals. In the time chart of FIG. **12**, the vertical axis represents an ON state at the upper position and an OFF state at the lower position. The horizontal axis represents the passage of time. The thick solid lines are of the control performed in the third embodiment while the thick dashed lines represent the control performed in the comparative example.

At the beginning of the process, controller **60** of image formation apparatus **10** turns ON first-optional-tray motor **92-3**, second-optional-tray motor **92-2**, resist motor **93**, fixation motor **96**, and high-voltage power supply **63** not illustrated in the time chart at step SIC. In addition, controller **60** drives drum motor **94** and belt motor **95** at the slow speed mode. The processes at steps S2 and S3 are the same as those in the first embodiment.

At step S**4**C, controller **60** of image formation apparatus **10** instructs optional tray controller **80** to stop first-optional-tray motor **92-3** and thereby to stop the rotations of pick-up roller **12-3** and sheet-feeder roller **13-3**. From then onwards, print medium **100** is conveyed without being driven by first-optional-tray motor **92-3** (pick-up roller **12-3** and sheet-feeder roller **13-3**). The processes at steps S**5** to S**7** are the same as those in the first embodiment.

At step S**30**, controller **60** waits for the turning ON of WR sensor **19** by the leading end of print medium **100** to be detected. Then at step S**31**, controller **60** waits for print medium **100** to be conveyed over distance D**5**. Then at step S**32**, controller **60** speeds up the drive speed of drum motor **94** and belt motor **95** to the printing speed. The processes at steps S**8** to S**15** are the same as those in the first embodiment.

(Effects of Third Embodiments)

Image formation apparatus **10** of this third embodiment slows down the drive speed of photosensitive drum **23** and conveyor belt **31** and thereby can prolong the service lives of these members, even if image formation apparatus **10** of this third embodiment is not equipped with special photosensitive drum **23** like the one in the second embodiment whose surface potential is less likely to be attenuated. In addition, image formation apparatus of this third embodiment can electrically charge the surface of each photosensitive drum **23** so sufficiently that the transfer can provide fine image quality.

## Fourth Embodiment

### Configuration of Fourth Embodiment

The configuration of image formation apparatus **10** of a fourth embodiment of the invention is identical to the configuration of image formation apparatus **10** of the first embodiment shown in FIG. **1**.

(Operations of Fourth Embodiment)

A feature of the fourth embodiment lies in the control method of a case where print medium **100** is conveyed over a long distance. So, the following description is given of the operations of a case where print medium **100** is fed from first optional tray **11-3**. If the conveyed distance is long, the operations of the fourth embodiment is also applicable to a case where print medium **100** is fed from second optional tray **11-2** and to a case where print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10**.

Image formation apparatus **10** receives, from an unillustrated external apparatus, print data and an instruction to make the printing be performed using print media **100** stored in first optional tray **11-3**. Then, image formation apparatus **10** makes first-optional-tray motor **92-3** rotate pick-up roller **12-3** and sheet-feeder roller **13-3**. With the rotations of pick-up roller **12-3**, each of print media **100** is separated from the others. Then, the print media **100** thus separated are sent, one by one, to the downstream side of the medium conveyance path.

As in the first to the third embodiments, in this fourth embodiment, on the basis of the print data sent from the host computer or the external apparatus, image processor circuit **61** as a size detector detects the conveyance-direction dimension of print medium **100**.

Print medium **100** conveyed from pick-up roller **12-3** is further conveyed by the rotation of sheet-feeder roller **13-3**. Note that in this fourth embodiment, the driving of resist motor **93**, fixation motor **96**, and second-optional-tray motor **92-2** is started substantially at the same time as the driving of first-optional-tray motor **92-3** is started. Unlike the comparative example, the driving of neither belt motor **95** nor drum motor **94** is started at that timing.

Note that, if the temperature of fixation roller **41** is at the target temperature, the driving of fixation motor **96** is started substantially at the same time as the feeding of print medium **100** is started as described earlier. If, conversely, the temperature of fixation roller **41** is lower than the target temperature, the driving of fixation motor **96** is started before the feeding of print medium **100** is started to warm up fixation roller **41**.

When sheet-feed sensor **14-3** detects that print medium **100** is fed properly, butting control to correct skew of print medium **100** is performed by using conveyance sensor **15-3** and conveyance rollers **16-3**. Print medium **100** passes through conveyance sensor **15-2**, conveyance rollers **16-2**, first IN-sensor **15-1**, first resist-roller pair **16-1**, and second IN-sensor **17**. Then, print medium **100** is conveyed to second resist-roller pair **18**.

In this fourth embodiment, if time T**1** elapses after controller **60** starts the feeding of print medium **100** from first optional tray **11-3**, an interrupt processing by timer **78** is performed. The interrupt processing is performed at a time when the conveyance distance of the print medium **100** measured from the position of the leading end of print medium **100** to the position of nip portion B becomes substantially equal to the conveyance distance measured from medium feeder F of main body of image formation apparatus **10** to the position of nip portion B. The position of the leading end of print medium **100** varies depending upon the structure of the apparatus and other factors. The timing of the interrupt processing may be delayed as long as the start of the rotations of photosensitive drum **23** and conveyor belt **31** allows the in-time arrival of print medium **100** for the transfer of toner images. The start of the rotations of belt motor **95** and drum motor **94** at this timing can reduce the rotations of photosensitive drum **23** and conveyor belt **31** which rotate wastefully under the control in the comparative example. Consequently, the wear of these members due to the idle rotations can be avoided. In addition, even if print medium **100** is fed from optional tray **11-3**, the rotations of conveyor belt **31** and photosensitive drum **23** is started at the same timing as in the case where print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10**. Hence, the surface of photosensitive drum **23** can be electrically charged reliably. As a consequence, the degradation of image quality due to charging failure can be avoided.

After that, print medium **100** is conveyed to second resist-roller pair **18**, and then passes through WR sensor **19**. Then print medium **100** gets on top of conveyor belt **31** to be conveyed further by conveyor belt **31**.

Print medium **100** turns ON WR sensor **19**, and then is conveyed to conveyor belt **31** that is located downstream in the medium conveyance path. Then, print medium **100** is conveyed sequentially to the four image formation units **22** of black (K), yellow (Y), magenta (M), and cyan (C), arranged in this order

Toner images of the four colors are transferred on print medium **100** by the image formation units **22**, and then the toner images are fixed to the surface of print medium **100** by fixation unit **40**.

After the toner images are fixed to the surface of print medium **100**, the leading end of print medium **100** is detected by EXIT sensor **51**, and print medium **100** is conveyed by the rotations of pairs of discharger rollers **52** to **54**. Note that, as in the first to the third embodiments, in this fourth embodiment, image processor circuit **61** as a medium-size detector detects the conveyance-direction dimension of print medium **100** on the basis of the print data sent from a host computer or an external apparatus. Hence, the rotations of conveyor belt **31** and photosensitive drum **23** can be stopped before the trailing end of print medium **100** completely passes through fixation roller **41** and then through EXIT sensor **51**. Specifically, the number of drive pulses of belt motor **95** after the detection of the leading end of print medium **100** by EXIT sensor **51** is measured, and then if it is judged that the trailing end of print medium **100** has passed through the image transfer position of the most downstream image formation unit **22-4** on the basis of the measured number of drive pulses, controller **60** stops belt motor **95** and drum motor **94**. A predetermined time after that, controller stops fixation motor **96**.

Print medium **100** thus conveyed is then discharged to stacker **55** or face-up stacker **56** through a discharge route selected by the user.

FIG. **13** is a flowchart illustrating the operations of image formation apparatus **10** according to the fourth embodiment of the invention. Elements therein that are the same as the ones that appear in FIG. **5** showing the first embodiment are denoted by their respective reference numerals.

FIG. **14** is a time chart illustrating the operations of image formation apparatus **10** of the fourth embodiment of the invention of a case where the charging-process suspension period does not exceed threshold time Tx. Elements in FIG. **14** same as the ones those in FIG. **6** showing the first embodiment are denoted by their respective reference numerals. In the time chart of FIG. **14**, the vertical axis represents an ON state at the upper position and an OFF state at the lower position. The horizontal axis represents the passage of time. The thick solid lines are of the control performed in the fourth embodiment while the thick dashed lines represent the control performed in the comparative example.

The process at step S1 is similar to that in the first embodiment. At step S3C, controller **60** waits until time T**1** (first time) measured by timer **78** elapses. Time T**1** is the length of time starting from the time when the conveyance of print medium **100** begins and ending at a predetermined time by which photosensitive drum **23** and conveyor belt **31** have to start rotating unless toner images cannot be transferred to the surface of print medium **100**.

In this fourth embodiment, time T**1** refers to the length of time starting from the feeding of print medium **100**, for example, from second optional tray **11-2** and ending at the time when the print medium **100** is conveyed to point P shown in FIG. **1**. Point P shown in FIG. **1** is a position, the distance from which to the position B where the toner image is transferred by image transfer device **21** is equal to the distance measured from pick-up roller **12-1** of medium feeder F of the main body of image formation apparatus **10** to the position B. The processes at steps S**4** to S**15** are the same as those in the first embodiment.

(Effects of Fourth Embodiment)

In image formation apparatus **10** of the fourth embodiment, the timing at which the rotations of photosensitive drum **23** and conveyor belt **31** are started is controlled by the interrupt processing by timer **78** only. Accordingly, the control can be made simpler and more accurate.

(Modifications)

The invention is not limited to the embodiments described above, but tolerates various other forms of use and modifications. Such various other forms of use and modifications include (a) to (e).

(a) The description of the first to the fourth embodiments is given with a color electrophotographic printer as an example. The invention is not limited to such a case, but is also applicable to other cases where the image formation apparatus is a monochrome photocopier, a color photocopier, a monochrome multifunction printer, a color multifunction printer, or the like with a similar structure.

(b) The description of the first to the fourth embodiments is of the case of direct-transfer image formation apparatus **10** where the toner image is transferred directly from each photosensitive drum **23** to print medium **100** conveyed by conveyor belt **31**. The invention, however, is not limited to such a case, but is also applicable to a case where the image formation apparatus is an intermediate-transfer image formation apparatus where the developer image is transferred firstly from each photosensitive drum **23** to an intermediate transfer belt serving as an image carrier and then the developer image on the intermediate transfer belt is transferred to the surface of print medium **100** that is being conveyed. In addition, the invention is also applicable to a case where image formation apparatus **10** is an image formation apparatus that uses no conveyor belt **31**.

(c) When there are plural medium feeders in a lower portion of image formation apparatus **10**, conveyance of the media and image formation may be performed as follows. First, source of print medium **100** is determined from the following: medium feeder F of the main body of image formation apparatus **10**; second optional tray **11-2** additionally provided to the main body of image formation apparatus **10** at the upstream side, in the medium-conveyance direction, of medium feeder F; and first optional tray **11-3** additionally provided to the main body of image formation apparatus **10** at the upstream side, in the medium-conveyance direction, of second optional tray **11-2**. Then the rotations of photosensitive drum **23** and conveyor belt **31** may be suspended in the preliminary operations for a length of time that is predetermined depending upon from which feeder print medium **100** is fed.

For example, if print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10**, the driving of neither photosensitive drum **23** nor conveyor belt **31** is suspended while print medium **100** is being conveyed from medium feeder F to image transfer device **21**. Alternatively, in the above-described case, the driving of photosensitive drum **23** and conveyor belt **31** is suspended temporarily at the same time as the feeding of print medium **100** is started, and then the driving of photosensitive drum **23** and conveyor belt **31** is resumed after a first time elapses since the start of the suspension.

If second optional tray **11-2** is additionally provided and print medium **100** is fed from this second optional tray **11-2**, the driving of photosensitive drum **23** and conveyor belt **31** is suspended temporarily along with the start of the feeding of print medium **100** while print medium **100** is being conveyed from second optional tray **11-2** to image transfer position B. Then, the driving of photosensitive drum **23** and conveyor belt **31** is resumed after a second time that is longer than the first time elapses.

If first optional tray **11-3** is additionally provided and print medium **100** is fed from this first optional tray **11-3**, the driving of photosensitive drum **23** and conveyor belt **31** is suspended temporarily along with the start of the feeding of print medium **100** while print medium **100** is being conveyed from first optional tray **11-3** to image transfer position B. Then, the driving of photosensitive drum **23** and conveyor belt **31** is resumed after a third time that is longer than the second time elapses.

(d) In the first to the fourth embodiments, both in the case where print medium **100** is fed from second optional tray **11-2** as the second medium feeder and in the case where print medium **100** is fed from first optional tray **11-3** as the first medium feeder, the driving of photosensitive drum **23** and conveyor belt **31** is suspended temporarily while print medium **100** is being conveyed. Even if, however, print medium **100** is fed from medium feeder F of the main body of image formation apparatus **10** as the third medium feeder, the driving of photosensitive drum **23** and conveyor belt **31** may be suspended temporarily on condition that the distance from medium feeder F to image transfer position B is sufficiently long or that the time from the start of conveyance of print medium **100** to the arrival of print medium **100** to image transfer position B is sufficiently long.

(e) In the first to the fourth embodiments, the conveyance-direction dimension of print medium **100** is identified on the basis of the print data sent from a host computer or an external apparatus, but this is not the only method of identifying the dimension. The conveyance-direction dimension of print medium **100** may be detected by detecting the conveyance speed of print medium **100** and the length of time between the turning ON and turning OFF of any one of sheet-feed sensor **14**, conveyance sensor **15**, first IN-sensor **15-1**, second IN-sensor **17**, and WR sensor **19**. Alternatively, the conveyance-direction dimension of print medium **100** may be detected by special sheet-size sensors provided in medium feeder F and optional trays **11** (**11-2** and **11-3**).

The invention includes other embodiments in addition to the above-described embodiments without departing from the spirit of the invention. The embodiments are to be considered in all respects as illustrative, and not restrictive. The scope of the invention is indicated by the appended claims rather than by the foregoing description. Hence, all configurations including the meaning and range within equivalent arrangements of the claims are intended to be embraced in the invention.

The invention claimed is:

1. An image formation apparatus comprising:

an image carrier on which a developer image is to be formed;

an image transfer device configured to transfer the developer image formed on the image carrier to a medium at an image transfer position;

a controller configured to control drive of the image carrier and the image transfer device;

a first medium feeder including a feed roller configured to feed the medium to the image transfer position along a medium conveyance path extending from the first medium feeder to the image transfer position; and

a medium detector provided between the feed roller and the image transfer position in the medium conveyance path,

wherein the controller is configured to control the drive of the image carrier on the basis of a medium-detection result by the medium detector, and

wherein the controller does not start driving the image carrier until the medium reaches at a predetermined position within a zone that allows transfer of the developer image to the medium to be performed at the image transfer position in time,

wherein the first medium feeder is a medium cassette provided upstream of a primary medium feeder along the medium conveyance path, and

wherein the medium detector is provided in the first medium feeder.

2. The image formation apparatus according to claim 1, wherein the zone that allows transfer of the developer image to the medium at image transfer position in time is a position whose distance to the image transfer position along the medium conveyance path is longer than a distance over which the image carrier moves after an image formation process to form the developer image on the image carrier is started until the transfer of the developer image formed on the image carrier to the medium is started.

3. The image formation apparatus according to claim 1, wherein the first medium feeder is optionally attached to an image formation apparatus body.

4. The image formation apparatus according to claim 1, wherein the controller starts driving the image carrier after the medium detector detects the medium being fed along the medium conveyance path.

5. The image formation apparatus according to claim 4, further comprising a second medium feeder provided upstream of the first medium feeder along the medium conveyance path, wherein

the controller starts driving the image carrier, after the medium detector detects the medium being conveyed from the second medium feeder toward the image transfer position along the medium conveyance path.

6. An image formation apparatus, comprising

an image carrier on which a developer image is to be formed;

an image transfer device configured to transfer the developer image formed on the image carrier to a medium at an image transfer position;

a controller configured to control drive of the image carrier and the image transfer device;

a first medium feeder including a feed roller configured to feed the medium to the image transfer position along a medium conveyance path extending from the first medium feeder to the image transfer position; and

a medium detector provided between the feed roller and the image transfer position in the medium conveyance path,

wherein the controller is configured to control the drive of the image carrier on the basis of a medium-detection result by the medium detector, and

wherein, until the medium reaches a predetermined position within a zone that allows transfer of the developer image to the medium at the image transfer position in time, the controller drives the image carrier at a lower speed than after the medium reaches the predetermined position.

7. The image formation apparatus according to claim 6, wherein the zone that allows transfer of the developer image to the medium at image transfer position in time is a position whose distance to the image transfer position along the medium conveyance path is longer than a distance over which the image carrier moves after an image formation process to form the developer image on the image carrier is started until the transfer of the developer image formed on the image carrier to the medium is started.

8. The image formation apparatus according to claim 6, wherein the first medium feeder is a medium cassette provided upstream of a primary medium feeder along the medium conveyance path, and

the medium detector is provided in the first medium feeder.

9. The image formation apparatus according to claim 8, wherein the first medium feeder is optionally attached to an image formation apparatus body.

10. The image formation apparatus according to claim 8, wherein after the medium detector detects the medium being conveyed from the first medium feeder toward to the image transfer position along the medium conveyance path, the controller drives the image carrier at a faster speed than before the medium detector detects the medium.

11. The image formation apparatus according to claim 10, further comprising a second medium feeder provided upstream of the first medium feeder along the medium conveyance path, wherein

after the medium detector detects the medium being conveyed from the second medium feeder toward the image transfer position along the medium conveyance path, the controller drives the image carrier at a faster speed than before the medium detector detects the medium.

12. An image formation apparatus, comprising:

an image carrier on which a developer image is to be formed;

an image transfer device configured to transfer the developer image formed on the image carrier to a medium at an image transfer position;

a controller configured to control drive of the image carrier and the image transfer device;

a first medium feeder including a feed roller configured to feed the medium to the image transfer position along a medium conveyance path extending from the first medium feeder to the image transfer position; and

a medium detector provided between the feed roller and the image transfer position in the medium conveyance path,

wherein the controller is configured to control the drive of the image carrier on the basis of a medium-detection result by the medium detector, and

wherein the controller starts driving the image carrier at a predetermined time after the medium detector detects the medium being feed along the medium conveyance path.

13. The image formation apparatus according to claim 12, wherein the controller starts driving the image carrier when the medium will arrive at the image transfer position in time for transfer of the developer image to the medium at the image transfer position.

14. The image formation apparatus according to claim 13, wherein the time when the medium will arrive at the image transfer position in time for the transfer of developer image to the medium at the image transfer position is time from which a time duration until the medium is conveyed to the image transfer position is longer than a time duration from the start of an image formation process to form the developer image on the image carrier until the start of the transfer of the developer image formed on the image carrier to the medium.

15. The image formation apparatus according to claim 12, wherein the first medium feeder is a medium cassette provided upstream of a primary medium feeder along the medium conveyance path, and

the medium detector is provided in the first medium feeder.

16. The image formation apparatus according to claim 15, wherein the first medium feeder is optionally attached to an image formation apparatus body.

17. The image formation apparatus according to claim 15, further comprising a second medium feeder provided upstream of the first medium feeder along the medium conveyance path, wherein

after the medium detector detects the medium being conveyed from the second medium feeder toward the image transfer position along the medium conveyance path, the controller drives the image carrier at a faster speed than before the medium detector detects the medium.

18. An image formation apparatus, comprising:

an image carrier on which a developer image is to be formed;

an image transfer device configured to transfer the developer image formed on the image carrier to a medium at an image transfer position;

a controller configured to control drive of the image carrier and the image transfer device;

a first medium feeder including a feed roller configured to feed the medium to the image transfer position along a medium conveyance path extending from the first medium feeder to the image transfer position; and

a medium detector provided between the feed roller and the image transfer position in the medium conveyance path,

wherein the controller is configured to control the drive of the image carrier on the basis of a medium-detection result by the medium detector, and

wherein, at a predetermined time after the medium detector detects the medium being conveyed toward the image transfer position along the medium conveyance path, the controller changes a driving speed of the image carrier to a faster speed than beforehand.

19. The image formation apparatus according to claim 18, wherein the controller starts driving the image carrier when the medium will arrive at the image transfer position in time for transfer of the developer image to the medium at the image transfer position.

20. The image formation apparatus according to claim 18, wherein, during the time when the medium will arrive at the image transfer position in time for the transfer of developer image to the medium at the image transfer position, the controller drives the image carrier at a lower speed than after the time.

21. The image formation apparatus according to claim 19, wherein the time when the medium will arrive at the image transfer position in time for the transfer of developer image to the medium at the image transfer position is time from which a time duration until the medium is conveyed to the image transfer position is longer than a time duration from the start of an image formation process to form the developer image on the image carrier until the start of the transfer of the developer image formed on the image carrier to the medium.

22. The image formation apparatus according to claim 18 wherein the first medium feeder is a medium cassette provided upstream of a primary medium feeder along the medium conveyance path, and

the medium detector is provided in the first medium feeder.

23. The image formation apparatus according to claim 22 wherein the first medium feeder is optionally attached to an image formation apparatus body.

24. The image formation apparatus according to claim 22 further comprising a second medium feeder provided upstream of the first medium feeder along the medium conveyance path, wherein

the controller starts driving the image carrier, after the medium detector detects the medium being conveyed from the second medium feeder toward the image transfer position along the medium conveyance path.

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